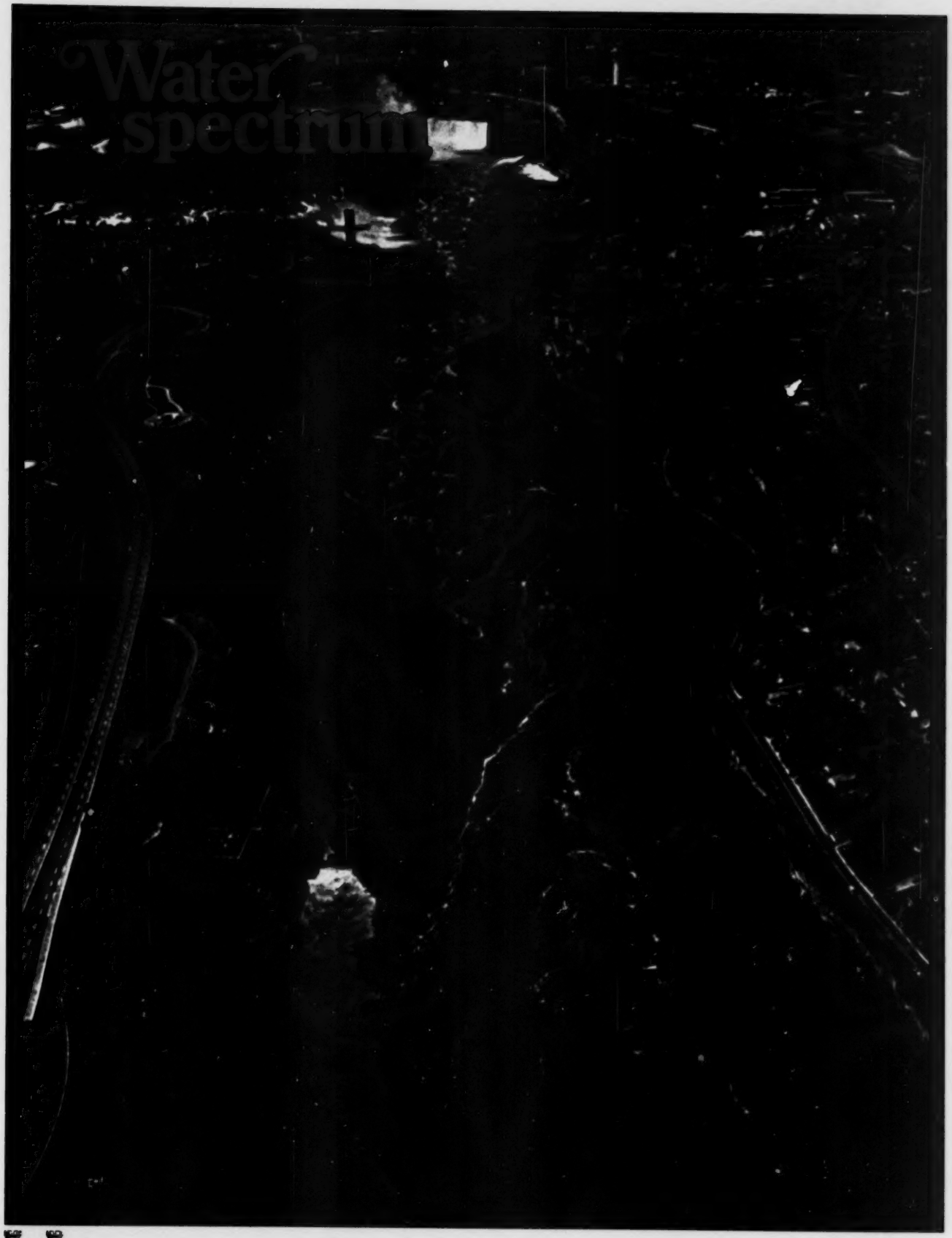
Water spectrum



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Water Spectrum
issues · choices · actions

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The riverboat of Mark Twain's day relied on nature's water levels to transport cotton and people up and down the inland waterways.

Front Cover-Discolored water at lower left outlines a municipal treatment outfall into Niagara River. See page 15.
EPA-DOCUMERICA George Burns

TOMORROW'S WATERWAYS

by DuWayne A. Koch

The options open to the waterway planner are clear: maximize navigation efficiency or accept prohibitive costs to shippers.

Today's life on the Mississippi has changed considerably since Mark Twain's time. In his era the romance of the river was reflected by the proud riverboats plying the channel between St. Louis and New Orleans, transporting their cargoes of cotton and people.

The side- and stern-wheelers no longer tie up at the mooring rings embedded in the old cobblestoned banks of the river towns, and the slap of the paddles against the water has been replaced by the throb of the diesel. Today the relaxed scenes of older riverside activities are all but forgotten in the hectic scramble to lock through and keep on schedule for the next river port-of-call.

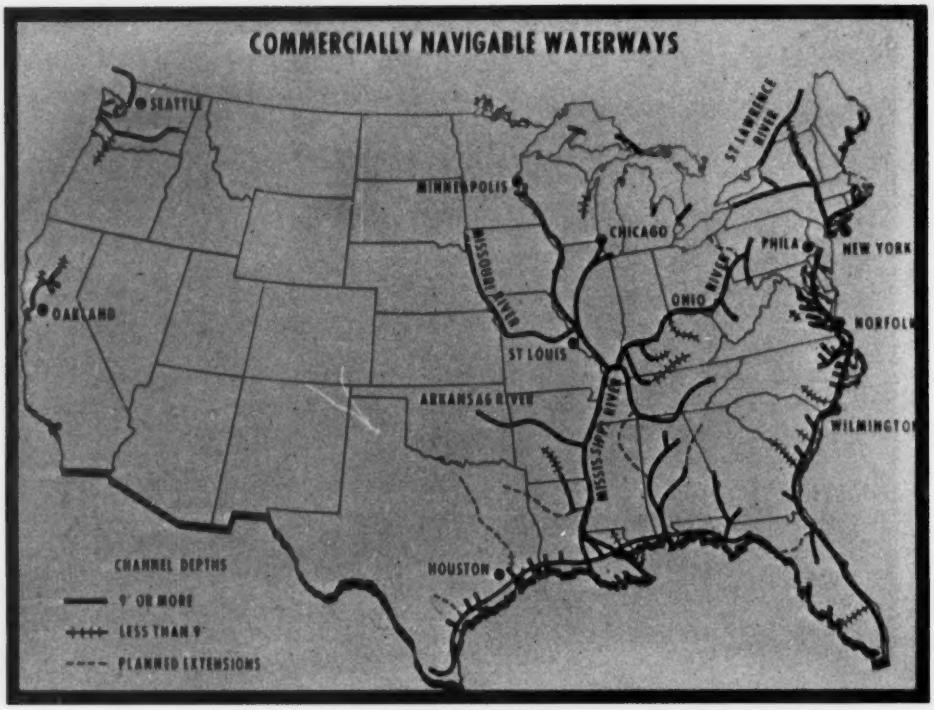
In Mark Twain's day there was no Lock and Dam 26 on the upper Mississippi, just above where the Missouri meets the Mississippi a few miles north of St. Louis. The musical calliope that formerly announced arrivals has been replaced by 2-way radio on which the towboat captain advises the lockmaster his tow is pushing from 3 to 30 barges laden with coal and steel and other bulk commodities.

Unlike the former shallow draft riverboat carrying its cargo on board, the modern tow works with a flexible number of deeper draft barges, some requiring as much as 9 feet of water.

Our system of inland waterways cannot meet these modern equipment depths without using dams to form pools of navigable depth behind them. That means every vessel approaching a navigation dam must either be lowered or lifted through it to the next water level. Even the mighty Mississippi, largest river in the system, could not supply enough water to assure minimum navigation depths all year without the numerous dams that now conserve its flow southward.

Today the United States has approximately 25,000 miles of navigable waterway, with 15,000 miles at depths of 9 feet or more. By 1970 our inland waterborne commerce industry consisted of nearly 2,300 vessels and

Mr. Koch is Chief of the Systems Analysis Applications Branch, Planning Division, Civil Works Directorate, Office of the Chief of Engineers.



Some 15,000 miles of the 25,000-mile system are maintained at a minimum depth of 9 feet or more.

about 15,200 barges belonging to some 1,800 different firms. The length of haul has increased 20-fold over the past 40 years, and the maximum tonnage of the individual tows has grown from 5,000 to 50,000 tons.

The heaviest movements throughout the inland system appear on the main stem of the Mississippi and the Gulf Intracoastal Waterway that stretches between western Florida and the Mexican border. About 80 percent of the traffic on the upper Mississippi and Illinois Waterway either originates or terminates on the lower Mississippi, the Gulf Intracoastal Waterway, or the Ohio or Missouri Rivers. Thus, every segment of the system is linked to the others through the flow of commodities from point to point.

As the number of tows using this system continues to climb with the growth of waterborne commerce, traffic noticeably begins to back up above and below certain locks. This not only creates delays in delivery dates, but forces the delayed tugs to seek temporary mooring accommodations safely out of the main channel, adding an additional strain and hazard where handling of dangerous cargo is involved.

Responsibility for reducing congestion at such points as Dam 26 has traditionally been given to the Corps, starting when Congress requested the first improvements to the Nation's waterways in 1824.

The traditional 600-foot-long by 110-foot-wide lock size was adopted about 1878 on the Ohio River when most of that traffic was downbound movement of coal during medium to high river stages. Shippers of the time

did not want locks unless they could be built big enough to permit passage of a steamboat and a fleet of at least ten 24- by 130-foot coal barges. These were usually made up into tows of four barges, or 96 feet, in width.

Since that time barges have grown in width up to 35 feet, making tow widths of 108 feet. Thus, there has been a steady encroachment of clearance space between tow and lock sizes, creating the need for larger locks.

In the past, however, Corps engineers were forced to rely only on the empirical evidence of observed delays in estimating when traffic volume increased beyond the designed capacity of a given lock. Plans would then be made to replace the congested lock with a larger one or expand the facility by adding a second lock at the same dam. Besides doubling the capacity, a twin lock could also move traffic in both directions simultaneously.

For instance, observed congestion at Mississippi Lock 26 would have been followed by an estimate of projected traffic through these locks for the next 50 years. If a new, larger locking facility could then be justified on the basis of its benefit-cost analysis, the new facility would be constructed as soon as an authorization and appropriation of funds occurred.

No longer is this considered an adequate solution. Too often we have been finding that dealing with an individual lock in isolation merely relocates the congestion problem to another site, since conditions in the rest of the inland waterways obviously influence that same traffic. It only takes one point of constriction to cause a bottleneck. In the past, though, we assumed that improvements would be made at other locations in proper sequence as those locations became congested. Consequently, every improvement in locking capacity was made without any clear assessment of its effects on the navigation system as a whole.

For many years the Corps realized that an improved method of determining and then evaluating exactly where future development would be needed belonged in our overall planning process for navigation projects. This thinking evolved into adoption by the Corps of a systems analysis approach as opposed to single project analysis. The technique to be employed, however, was not decided upon until 1970 when the Secretary of the Army's office requested the Corps to apply its systems analysis logic to the entire inland waterway network.

At that time mathematical modeling was selected over physical modeling due to the comparative ease and speed with which mathematical modeling could be accomplished on a computer. Besides, the Corps already possessed a computer program with the ability to mathematically simulate fairly large and complex subsystems. Furthermore, the Corps' computer modeling capability had been tested on the Mississippi Lock 26 problem

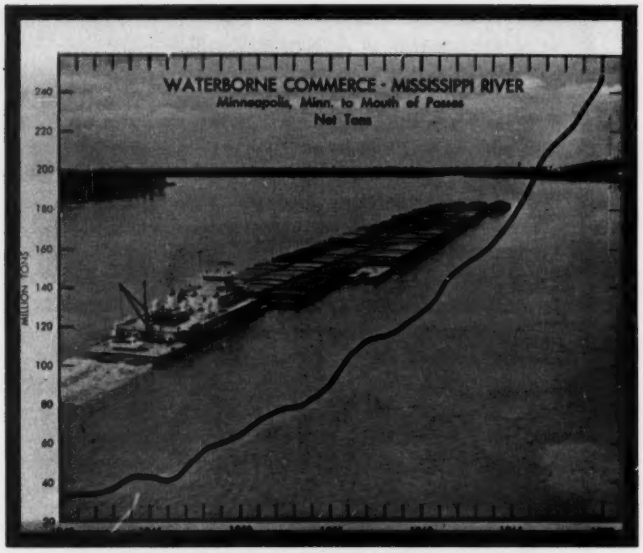
Growth of industrial activity along inland waterways generates waterborne commerce.

through a series of simulated runs.

Here was a bottleneck that had been with the Corps for several years. While it was known that the facilities would have to be upgraded, no one could say for sure which combination of lock improvements would be the best. Perhaps only one 1200-foot lock and one 600-foot lock would be sufficient. On the other hand two 1200-foot locks might be better. Furthermore, this decision could be influenced by what improvements were contemplated for the other locks in the system. What good would it be to construct new 1200-foot locks at one site, when a series of 600-foot locks at other damsites would still restrict the river traffic?

We already knew that to ease the congestion on the upper Mississippi the 600- and 300-foot locks at 26 were due for replacement. The queues of tows observed there have cost the towing industry thousands of hours that are in turn reflected in the general costs of the final products sold to the consumer.

We started on the locks at 26 by observing the average delay per tow between January 1968 through January 1972. Then we verified our computer



Each year brings new highs in waterborne commerce, requiring continual improvement of lockage facilities.

Aerial view of Industrial Canal Lock in vicinity of New Orleans shows typical tow activity near intersection of Mississippi main stem with Gulf Intracoastal Waterway.

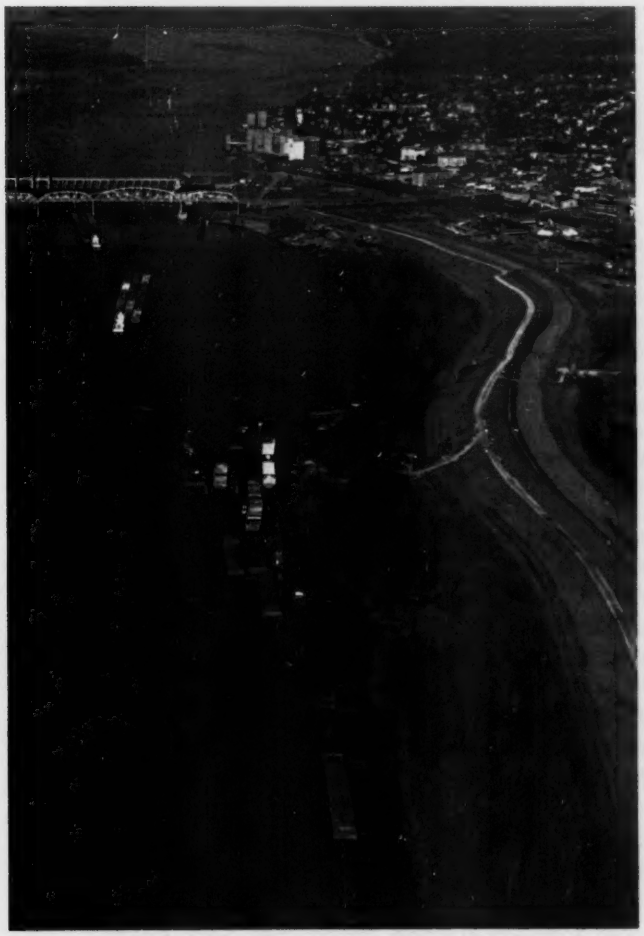
results by calibrating the first simulated run against actual 1968 data. Since the traffic level for a typical 1968 month was known to be 3.8 million tons, the computer simulation model used this amount of traffic throughout all the runs. The average delay at both locks exceeded 2.5 hours per tow. Any delays beyond 2.5 hours in duration meant we had a situation that would soon progress to the point where tows would be arriving faster than they could lock through. The resultant queues would become longer and longer as they approached infinity.

For example, by projecting the construction of twin 1200-foot locks into future years, simulation run 5 came up with an average delay of only .75 hour per tow for the year 2020. Simulation run 6, however, with the same lock capacity for the year 2027, showed a delay per tow exceeding 4.5 hours—well above the 2.5 hour delay defined as the acceptable average limit for this site.

By interpolating between the results of runs 5 and 6, it became possible to find out the approximate year the 2.5 hour delay was exceeded. The computer determined this level of traffic would be reached in the year 2025 using the proposed twin 1200-foot locks to move a computer-projected traffic volume of 170.5 million tons. By comparison, the current Corps plan based on the same option of constructing twin 1200-foot locks estimates this traffic capacity at 161.6 million tons. Since the project plan calls for the first full year of operation starting in 1982, the new locks would begin to encounter serious delays in the 44th year of the project's 50-year life.

Not only is this 6 years short of the anticipated project life, but if the traffic volumes forecast for these years are underestimated the project would definitely reach capacity prematurely. Therefore, the project has been designed so a third lock can be added, if needed, without disrupting traffic and incurring costly changes in the existing structures.

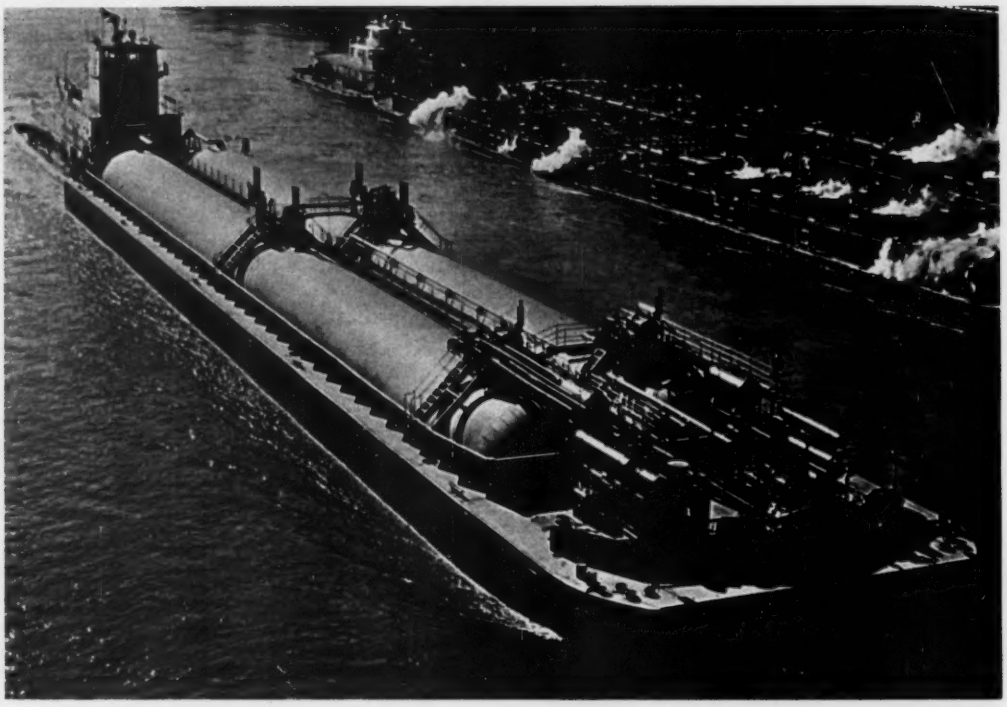
Each simulated run included use of typical tows developed from traffic forecasts. The computer processed each tow through the total simulated system of channels, locks, bridges and narrow delay points, tracing each tow's movement by computing the time required to move from one point to the next in the simulated system. If a lock was currently in use when the tow arrived, that tow was automatically held in queue and the delay time recorded.



Steady growth in barge width has encroached on the amount of clearance between tows and locks.

Aerial (left) and surface views of current congestion at Lock 26 indicate need for larger installation to reduce tow waiting times. Railroad swing bridge next to lock must be opened to clear each tow boat.

These specialty barges represent a navigation industry response to inland waterway requirements.



The Corps also built a hydraulic model of Lock 26. These model studies showed that the proposed locks should be separated by at least 350 feet to permit unrestricted movement of tow traffic. The situation at a set of double locks is similar to that of a highway cloverleaf, where separating the roadbeds removes constrictions in the traffic flow. In this way lock capacity can be expanded without increasing lock size.

Our own experience, use of hydraulic models and computer verifications also showed the advantage of constructing a separate small-boat lock for recreational craft. Should such a lock ever become necessary, it would probably be constructed on the opposite side of the river from the large commercial locks. This would provide a safer passage through the new dam, which will be built about 2 miles downstream from the existing site.

The expanded facilities contemplated for the new Dam 26 are also based on the effect of several other locks in the system reaching their respective capacities beforehand and being improved during the life of 26, thus making Dam 26's locks viable through the year 2032. As each of the other facilities in the system are replaced by new locks, their accumulative benefits to navigation should keep the upper Mississippi part of the system balanced with facilities compatible with those at Dam 26.

While these results were very helpful, we must remember that we are attempting to simulate a physical waterway, a dynamic system whose characteristics keep changing with time. Channels are widened, bends are straightened, new bridge piers are constructed that protrude into the channel, smaller locks are replaced by larger facilities and new river ports spring into being near developing industrial areas. Obvious changes can be identified geographically on a localized scale. Observation of the total system, however, is necessary to capture the cause-and-effect consequences on navigation.

The navigation industry itself affects the efficiency of the system as the size, draft, and horsepower of ships, tows, and barges change. These changes may be due to differences in the types of cargoes being carried and technological advances in equipment built to navigate the peculiarities of the inland waterways. The barge configuration most appropriate for moving low value bulk commodities, such as coal and petroleum, long distances must also be projected. Since these commodities can also be transported by competing modes, the shipper will generally choose the least costly method which also satisfies all his other requirements, such as speed and handling.

Injecting these considerations into our systems analysis brings out the interrelationships of commodity flows to existing navigation facilities. For example, approximately 3.8 million tons of coal are projected to move from the southern Illinois coal fields on the Kaskaskia River via a new navigation canal to utility plants under construction on the banks of the upper Mississippi. These plants are expected to be ready to re-

Hydraulic model of future Dam and Lock 26 simulates tow movements through proposed twin 1200-foot locks. Traffic flow will be separated by width of two tainter gates to reduce congestion hazards.

ceive their coal input in 1978. By 1980, the volume of coal to be shipped is expected to increase to an annual level of approximately 6 million tons.

When shipped by water, some of this new tonnage will move up the Mississippi through the existing locks at Dam 26. Since operation of the first replacement lock of the new pair is projected for 1981, the current pair of smaller locks will be asked to add some of this tonnage to its present traffic during the interim 3 years. The present traffic is already well beyond its 45-million-ton estimated capacity.

These hard facts demonstrate that systems analysis should not be restricted to the design and evaluation of a recommended navigation improvement. It should also be a part of scheduling the resultant construction. Current systemwide information should *follow* the project from its initial survey stage through its actual authorization and construction. Then the knowledge available on these system interrelationships can be used to schedule the timing of construction fund requests.

Up to now the development and scheduling of inland navigation improvement programs have been based largely on judgmental factors. No methodology existed with which to evaluate the effects that individual changes would cause to the entire navigation system. This lack of a systematic methodology has, in some instances, resulted in building an over capacity at some locations while inadequate capacity problems simultaneously developed at others.

On the operational side of the coin, direct benefits to shippers and tow operators would include better scheduling of tow movements and more efficient utilization of towing equipment. The tow operator and his shipper must think in terms of total trip time. Their benefits and costs are spread over all the existing conditions they will encounter from origin to destination. Therefore, an actual reduction in overall trip delays is the only meaningful criterion to the shipper and to the consumer, who also benefits from the economics of low-cost water transportation.

By 1976 the Inland Navigation System Analysis (INSA) program will be well enough along to have in existence procedures that can analyze individual projects on a systemwide basis. These procedures are now being developed for INSA through in-house research and multiple contracts, which should be completed by that date. We also anticipate a completed mathematical simulation model at that time.

Bringing all these components of INSA together at one time will provide the tools to design and schedule the construction of improvements to the entire inland waterway network of channels, dams and locks as a truly integrated system. We look forward to that time with anticipation.■

A TURNING POINT

The new Flood Disaster Protection Act of 1973 in effect forces the Nation's flood-prone communities to practice some form of flood plain management for new construction in areas subject to flooding

by George K. Bernstein
Federal Insurance Administrator
Department of Housing and Urban Development

The Nation has reached a turning point in its approach towards flood loss prevention with the signing into law of the Flood Disaster Protection Act of 1973. Recognizing that we can no longer tolerate the losses of lives and property that result from the unwise and unrestrained use of our flood plains, the Congress enacted this legislation to reduce the toll from one of the most destructive hazards facing the people of the United States.

For the first time every flood-prone community in the Nation will be required to guide new construction in areas subject to flooding so as to minimize flood damage. No longer will communities be able to allow indiscriminate building in flood hazard areas. With this legislation a nationwide application of the principles of flood plain management is possible.

In addition, for the first time property owners in flood-prone areas are required to purchase flood insurance as a condition of any form of Federal or federally related financial assistance for acquisition or construction of buildings in identified special flood hazard areas.

With the broader coverage provided by the new act, victims of flood disasters can now be more adequately and speedily reimbursed for their losses through flood insurance. The legislation makes possible the eventual substitution of Federal flood insurance for the current cumbersome and often inequitable system of Federal disaster loans, which may add to the financial burdens of distressed disaster victims, rather than alleviate them.

In recent years, the Federal Government has spent many billions of dollars to indemnify flood victims for property losses. Since 1936 more than $7 billion have been spent to construct flood protection works. Yet, annual flood losses amount to about $1.25 billion and are continuing to increase, largely as a result of the improper use of the Nation's flood plains.

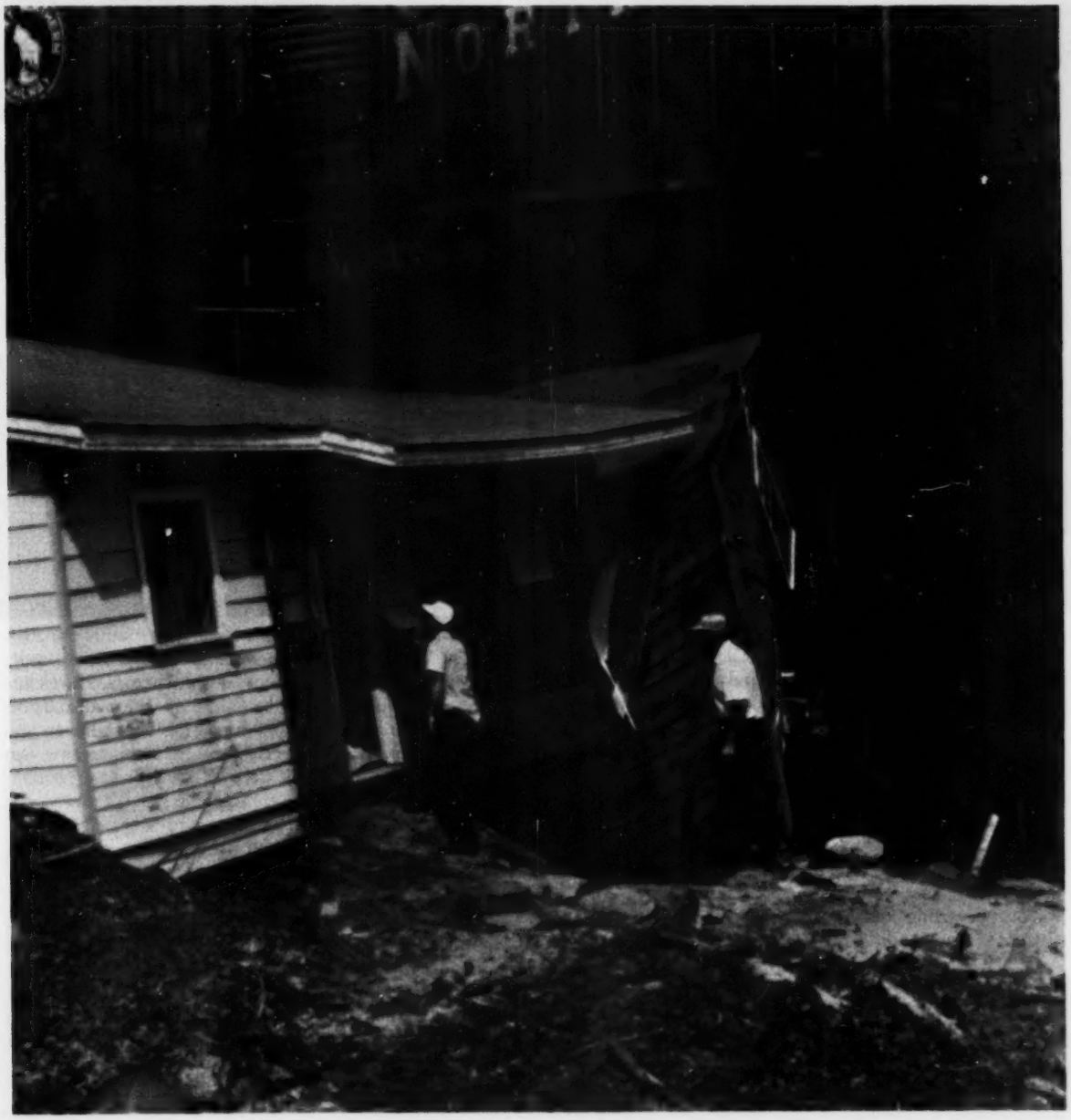
As shown in a study requested of HUD by the Congress on the feasibility of a National Flood Insurance Program, the flood damage hazard in the United States

was constantly rising as increasing numbers of people moved to coastal and river locations to live, for recreation, for business, and for other purposes. In addition, unwise development, reflecting ignorance or indifference, and sometimes an overestimation of the flood protection actually provided, increased the demand for property in flood-prone areas, thus setting into motion processes whereby flood damages were accelerated.

Another of the study's major conclusions was that many people in high flood risk areas are seriously uninformed about the risks of flooding to which they are exposed, or that they are grossly over-optimistic about the chances that their property will not be flooded, or else that they expect public help to bail them out when the inevitable flood disaster strikes.

he HUD study affirmed the feasibility of a program to offer flood insurance at subsidized premium rates for those who had built in hazardous areas without fully knowing or understanding the consequences. However, it emphasized that such a program would be viable only under two conditions: if actuarial (nonsubsidized) premium rates were charged for future construction in flood plains; and only if communities were required to implement land use and control measures to reduce or avoid future losses. In return they would receive the benefit of subsidized flood insurance protection for previously existing structures.

When these uninsured houses floated into a railway trestle over the Strong River in Mississippi, only one owner in the community carried flood insurance. It was available at the time under the emergency insurance program.



Right-Flood damages to new stereo and kitchen equipment increase the owner's heavy uninsured losses.

Below-These flood-soaked rugs are from a house on the fringe of a flood plain. A newly incorporated city government is moving to comply with eligibility requirements so flood insurance can be made available to community residents.

Below-right-While flood victims were making repairs after the '74 spring flood in this community (which had been suspended from the program until eligibility requirements were met), the city administration stepped up efforts to get reinstated.

The Congress accepted the HUD report's recommendation for sound land use and control measures when it passed the National Flood Insurance Act of 1968. At that time the Federal Insurance Administration was made responsible for the National Flood Insurance Program.

As of March 15, 1974, 3,289 communities were participating in the National Flood Insurance Program. However, over 11,000 more flood-prone communities have not yet applied for eligibility for the sale of flood insurance.

The prevailing attitude of many local officials and citizens is that floods "can't happen to me." Such was the case in Wilkes-Barre, Pa., where only two flood insurance policies were in effect at the time of Hurricane Agnes.

Many communities along the Mississippi River and the Great Lakes were not eligible for flood insurance last spring when floodwaters were at their peak. The conditions in spring 1974 again threatened several areas. Although a number of Great Lakes and Mississippi River communities have joined the program in the past year, there are still many that have not provided flood insurance protection to their residents.

It thus became clear that the voluntary nature of the National Flood Insurance Program was its major defect and that, without mandating provisions to bring about sound flood plain management, no real accomplishment towards reducing flood losses could be made. The Congress recognized that fact and passed the Flood

Disaster Protection Act of 1973, which expands and improves the 1968 Flood Insurance Program by:

- at least doubling the limits of insurance coverage.
- extending the emergency program for 2 more years, thus assuring that individuals and communities can continue to obtain flood insurance that would otherwise be unavailable.
- removing the limit on the total amount of insurance which can be written.
- creating incentives for flood-prone communities to enter the program and thereby make insurance available to their citizens.
- requiring insurance on all Federal or federally assisted financing of buildings in flood-prone areas.
- accelerating the completion of rate studies for flood-prone communities.
- establishing explicit procedures for communities wishing to appeal, on a technical basis, HUD's flood elevation determinations for land use purposes.

With these measures the National Flood Insurance Program will be able to provide the certainty of financial protection for anyone who decides that it may be necessary to build in flood-prone areas in the future. Communities will be required to strengthen their commitments to flood preventive efforts, thus lessening the disastrous results of flooding and easing the burden on all taxpayers.

The following paragraphs discuss the major provisions of the Flood Disaster Protection Act of 1973.

Insurance Coverage and Limits

Under the act, subsidized premium rates are available for flood insurance on all construction begun on or before December 31, 1974, or the effective date of the Federal Insurance Administration maps, whichever is later. The maps are based on detailed rate and elevation studies.

The full actuarial rates apply for all construction located in the identified flood hazard area begun after that date. Actuarial rates may be five to ten times higher than the subsidized rate if the structure is not properly elevated or floodproofed.

The accompanying table shows the new limits of subsidized coverage and the reduced subsidized premium rates. Additional amounts of coverage, double the limits shown in the table, are available at actuarial (nonsubsidized) rates in communities where rate and elevation studies have been completed.

The flood insurance policy covers property losses resulting from a general condition of flooding, from erosion caused by abnormal water levels and similar unforeseeable conditions, and from flood-related mudflows.

Requirement to Purchase Flood Insurance

Just as fire insurance is generally required in connection with all mortgages, the Flood Disaster Protection Act of 1973 requires the purchase of flood insurance in connection with all forms of loans and grants for buildings located in special flood hazard areas where Federal flood insurance is available.

In addition, the act directs each Federal instrumentality responsible for the supervision, approval, regulation or insuring of banks, savings and loan associations or similar institutions to issue regulations requiring that persons receiving mortgage loans approved by such institutions after March 1, 1974, must also purchase flood insurance—but only if the property securing the loan is to be located within an identified special flood hazard area of a community eligible for flood insurance. The requirement affects all new loans, as well as modifications of outstanding loans. It does not affect existing loans for which no new approvals or changes in conditions have been requested.

With this requirement the Federal Government takes the stand that—for both humane and economic reasons—it will not finance any building located within a known flood-prone area unless it is protected by flood insurance.

No undue hardship should result from the insurance purchase requirements of the legislation. Therefore, a 1-year grace period is provided to defer the application of actuarial premium rates for the first layer of flood insurance coverage on new construction. Subsidized rates, however, can be charged for all construction that has already occurred and that will occur until December 31, 1974, or the effective date of publication of the Flood Insurance Rate Map for that community, whichever is later. This provision prevents owners of new structures, in communities where 100-year flood elevation informa-

LIMITS OF COVERAGE AND SUBSIDIZED RATES

Type of Structure	Structure		Contents**	
	Coverage	Rates per $100 of coverage	Coverage (per unit)	Rates per $100 of coverage
Single family residential	$35,000	$0.25	$10,000	$0.35
All other residential	$100,000	$0.25	$10,000	$0.35
All nonresidential*	$100,000	$0.40	$100,000	$0.75

** Includes hotels and motels with normal occupancy of less than 6 months.*

*** Tenants of each unit of both residential and nonresidential buildings may purchase contents coverage independent of structural coverage.*

Right-At this uninsured, flood-damaged house the work is being done by someone who just came to help. Residents of the town were eligible to take out flood insurance, but no concerted local effort had been made to enroll participants.

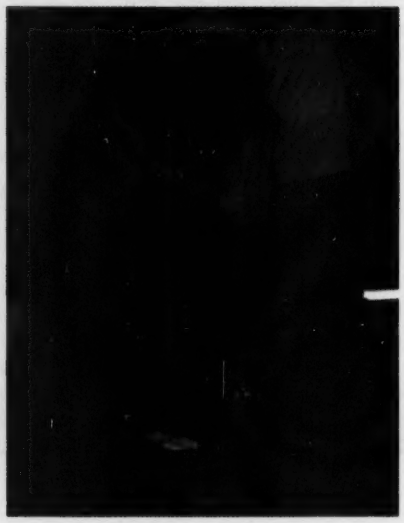
Below-The '74 spring flood in Mississippi came fast and exceeded the level that can be expected once every 100 years. Some barely made it to safe ground. An objective of the National Insurance Program is to reduce such risks through incentives for stringent zoning requirements in flood hazard areas.

Bottom-Subsidized flood insurance for commercial firms has been expanded from small businesses under the 1968 act to industrial and similar facilities under the revised act of 1973.

Right-center-This uninsured house with its flood-damaged floors and windows is located in a county that was declared a disaster area, making the owner eligible to apply for a disaster loan. In the future, any federally assisted bank or lending firm will not be permitted to make loans for renovation of uninsured flood-damaged property located in a flood hazard area.

Right-bottom-The owner of this mobile home carried flood insurance, so contractors working for an insurance company make the flood damage repairs.

Burton Steele, Hattiesburg, Miss.



The cost of this type of repair in the flood plain is borne entirely by taxpayers and represents a continuing financial risk whenever people settle and live in flood hazard areas.

tion has been provided, from being penalized by an elevation requirement they did not know about or sufficiently understand at the time of construction.

The requirement for the purchase of flood insurance also applies to Federal disaster assistance loans or grants for permanent repair or reconstruction after a catastrophe. Flood insurance will be required in connection with the obtaining of such assistance, even if a flood does not cause the disaster.

Notification to Flood-Prone Communities

Under Section 201 of the act, the Secretary of HUD is required to notify all flood-prone communities in the Nation of their tentative identification as such by July 1, 1974. The community then must either make prompt application for participation in the program or satisfy the Secretary that it is no longer flood prone. The Secretary would have the option of holding a public hearing where conflicting data exist, but his determination in the matter would be final.

Communities having identified flood-prone areas are required to participate in the flood insurance program by July 1, 1975, or be denied both Federal financial assistance for acquisition or construction purposes and federally-related financing by private lending institutions for use in areas identified by HUD as special flood hazard areas.

This provision contains the "teeth" of the legislation. After July 1, 1975, taxpayers throughout the Nation will no longer have to subsidize construction in the flood-prone areas of communities that do not take the necessary measures to avoid or reduce flood damage.

The pressures on local officials for indiscriminate development of the community's flood plain should be greatly reduced. Local decisions regarding how the flood plain is to be used will be predicated upon the fact that the lives and property of the residents must be protected. For the first time every flood-prone community in the Nation will be required to implement and enforce wise land use practices with respect to its flood-prone areas.

Individuals in every flood-prone community will also be eligible to protect their property by purchasing Federal flood insurance. In the event of flood damage, they will be reimbursed for any covered losses.

Eventually flood insurance will replace Federal disaster relief for most flood occurrences, thus reducing the demands on the Federal Treasury. Property owners in flood-prone areas will be contributing to their own

Annual flood losses are about $1.25 billion, largely because people have built in flood zones instead of on higher flood-safe land.

protection, and therefore will be more fully indemnified (without having to repay a Federal disaster loan) when a flood loss actually occurs.

Consultation with Local Community Officials

The Secretary, in carrying out his land use responsibilities under the act, is required to establish procedures assuring adequate consultation with appropriate elected officials of local governments. Such consultation is specifically required with respect to many areas of local concern. Thus, the Secretary is required to encourage local officials to disseminate information widely on any study he undertakes, in order to permit submissions of relevant data by interested members of the public.

Appeals

The act establishes explicit appeals procedures for both individuals and communities desiring to challenge the Secretary's proposed determinations relating to minimum construction elevation standards and sets out the scope of judicial review of such determinations.

The act assures individuals and communities a full opportunity to be heard and to appeal, if aggrieved. It sets forth a comprehensive system of providing actual notice to persons affected by elevation determinations—not only through publication in the Federal Register, but also through direct notification to the chief executive officer in the community and publication of proposed determinations in a prominent local newspaper.

Repeal of Disaster Assistance Penalty

The new legislation repeals Section 1314 of the National Flood Insurance Act of 1968, which would have denied Federal financial disaster assistance—effective January 1, 1974—to those who could have purchased flood insurance for a year or more but did not do so. The 1973 Flood Disaster Protection Act replaces that provision with the requirement that flood insurance must be purchased in connection with any form of Federal financial assistance for buildings in flood-prone areas. However, if a flood-prone community is not participating in the program by the new deadline of July 1, 1975, no Federal financial disaster assistance will be available for properties in identified special flood hazard areas.

The Flood Disaster Protection Act of 1973 offers a practical, economically sound way of financial protection for property owners from the ravages of floods, while easing the burden on the general public. By requiring communities to implement programs of flood plain management, the Nation can be assured of reduced flood losses in the future. ■

Five previous articles on treating land with wastewater appeared during a period when acceptance was clouded by public misunderstanding of the method. The articles called attention to the sheer waste of a valuable resource, and they compared land treatment and water reuse against traditional wastewater disposal into the Nation's waterways.

Then, in mid-1974, the new era arrived. For Federal grant eligibility for wastewater treatment construction, EPA now requires applicants to consider all alternative methods—including land treatment.

In this article the authors discuss legal points communities must consider in evaluating these land treatment alternatives.

WASTEWATER IRRIGATION: Its Legal Impact

Application of land treatment in the United States must come to grips with a number of potential legal constraints related to wastewater management, land use, and water rights.

by William R. Walker and William E. Cox

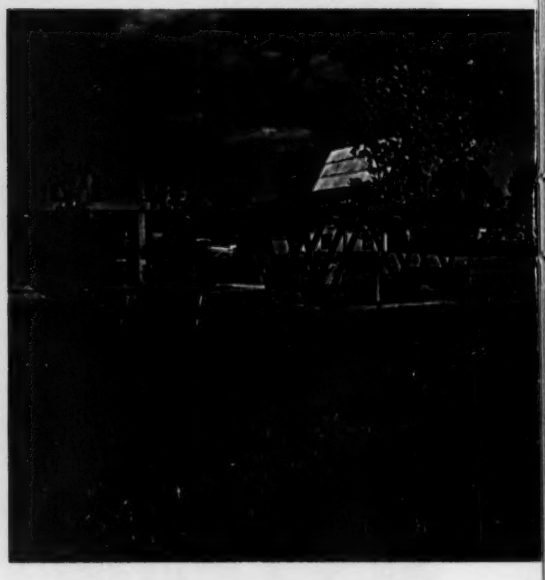
Future world demand for production of agricultural commodities will strain available water supplies as never before. Prior estimates of demand may well be grossly understated in the face of ever expanding requirements for use of water in producing more energy to meet our current crisis. We are fast approaching an era in which we may be forced to alter legal attitudes toward the role of wastewater resources in our economy; for *effective management of wastewater soon may evolve from a highly desirable to an absolutely essential societal goal.*

Recycling municipally produced sludge and effluent as an alternative form of waste disposal has not had the benefit of as in-depth an evaluation as other methods. No assessment would be complete without some discussion of the institutional processes by which this waste management scheme functions.

Dr. Walker is director and Mr. Cox a research associate at the Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Blacksburg, Va.

Only a few States regulate the type of crops that may be grown on wastewater-irrigated lands.

A fish-eye lens imparts a global effect to outfall from a municipal sewage treatment plant into the Des Moines River.



Although these institutional considerations include such diverse matters as the form and powers of water organization, financial arrangements, public attitudes and political traditions, we will concentrate on the legal constraints for waste management manifested in legislative enactments. In addition to legislative enactments, the corollary common law rights of property owners influence land use and, therefore, also assert their control over this disposal technique. Finally, we will analyze the impacts of both the statutory and common law rights related to water use, since land application of wastewater alters the normal flow regimens of both surface and ground water.

Governmental Wastewater Management Controls

Historically, the first comprehensive effort at wastewater management at the Federal level came with the passage of the Water Pollution Control Act of 1948. It allowed the State governments to retain primary responsibility for pollution control as a matter related more to the exercise of public health guides than the use of a valuable resource.

By the time the Federal Water Pollution Control Act of 1956 was enacted into law, treatment of wastewater had come to be regarded as worthy of more direct Federal attention. This act authorized Federal grants to assist State and municipal governments in planning and building the treatment facilities, but contained no provisions for purchase of land for sewage treatment or for grants in connection with the recycling and reclamation of wastewater.

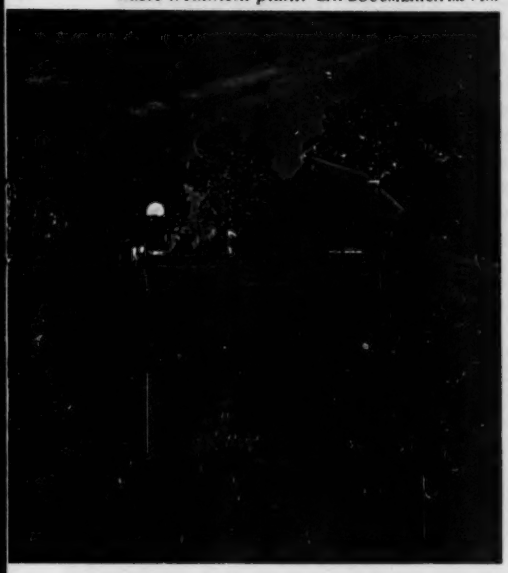
It was not until the Federal Water Pollution Control Act Amendments of 1972 that a national policy was established to develop the technology that could eliminate discharge of pollutants into our navigable waters. In addition, several provisions in the amendments gave impetus to considering land disposal of wastes as a serious alternative for alleviating the water pollution problem.

One source of encouragement for wastewater management arises when provisions for increased levels of waste treatment are considered jointly with additional restrictions on disposal of sludge resulting from treatment. The amendments require that publicly-owned treatment plants achieve a secondary-treatment level of performance by 1977, including removal of all floatable solids and 85 percent of the suspended solids. Besides increasing the costs of treatment, this requirement will create greater quantities of sludge for disposal. Yet the same legislation restricts ocean disposal of sludge in some cases. Thus, an incentive to initiate land application of both wastewater effluent and sludge is created.

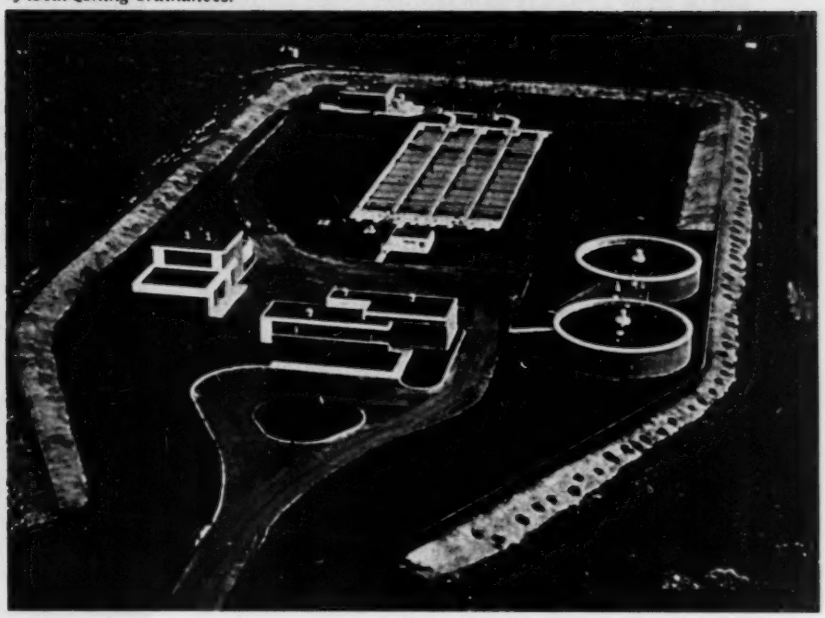
The reversal of Federal attitude from that expressed in the earlier legislation is reflected by those provisions of the 1972 Amendments which permit application of Federal grants toward acquisition of land that is to be an integral part of the treatment process or receives the disposal residues resulting from sewage treatment. Such grants, though, still cannot be utilized in acquiring land for building conventional treatment plants.

The 1972 Amendments specifically refer to recycling potential sewage pollutants in connection with agriculture, silviculture, or aquaculture in requiring the Environmental Protection Agency (EPA) to encourage

This grassy picnic spot within a residential area in Freehold, N.J., can hardly be called a nuisance, yet it camouflages a waste treatment plant. EPA-DOCUMERICA Ike Vern



Building sewage treatment plants in residential districts may or may not be restricted, according to interpretation of local zoning ordinances.



development of revenue-producing waste treatment facilities. Regulations promulgated by EPA for implementing the amendments contain guidelines for cost effectiveness analysis that specifically include considering land or subsurface disposal techniques as feasible alternatives.

Although this most recent manifestation of Federal interest in water quality encourages the use of land disposal where it is cost effective, the 1972 Amendments express an intent to ultimately place basic responsibility with the States for implementation. The primary Federal control is the requirement that EPA approve each State's internal permit program.

Within State governments, acceptance of the land disposal concept varies. A 1972 study by Temple University indicated 14 States with a favorable orientation, 11 with a negative outlook, and the remaining 25 either neutral or not classifiable.[1] This study indicates that more than two-thirds of the States had no specific regulations in effect concerning land application of wastewater.

The Temple University finding correlates with a survey conducted by the American Public Works Association among State health and water pollution control agencies. This survey indicates most State agencies have no set policies on this phase of wastewater handling or its attendant environmental impacts, do not impose specific conditions on installations, inspect existing systems infrequently, and seldom require monitoring procedures and filing of official reports on operations.

Only five States responding to the survey indicated they had requirements governing irrigation with wastewater. These were Arkansas, Arizona, Colorado, New Mexico, and Texas. Of these five, only four have rules governing the type of crops approved for wastewater-irrigated lands. Crops permitted range from *forage only* to *all types.* These States also specify the quality of effluent that may be applied. Texas prohibits wastewater irrigation of any crops that are to be consumed in a raw state.[2]

In addition to those mentioned, there are other States with some form of control that applies to land uses. For example, California and Idaho have land use regulations that appear to cover any proposals for wastewater irrigation in those States.

Land Use Controls

Policy concerning land use control is currently undergoing considerable reevaluation in a number of States. Until definite programs are implemented, most States will continue to rely on the traditional controls imposed by local zoning ordinances. Applicability of zoning ordinances to land treatment facilities is a complicated matter because of dependence on such factors as the provisions of the State's enabling legislation and the terms of the particular ordinance involved in a given situation. Two specific situations raise significant questions. The first concerns the extent to which a governing body is subject to its own zoning restrictions.

[1]Center for the Study of Federalism, *Green Land—Clean Streams: The Beneficial Use of Wastewater Through Land Treatment,* Temple University, Philadelphia, 1972, p. 226.

[2]EPA, *Survey of Facilities Using Land Application of Wastewater,* Washington, 1973, p. 99.

The second involves application of another governmental entity's restrictions to facilities to be constructed on land lying outside the owning jurisdiction.

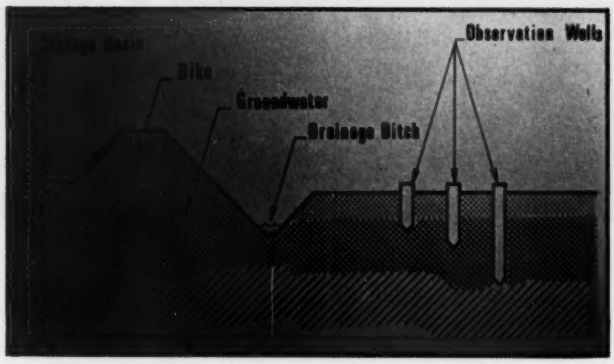
The answer to the first question is frequently provided by the zoning ordinances themselves, which may exempt governmental uses from conforming to their own provisions. For example, in 1952 the Supreme Court of Pennsylvania upheld the right of a municipality to construct a sewage treatment plant in a residential district since the zoning ordinance specifically permitted "municipal use."

Where no specific ordinance exception is made for a governmental use, the decision is sometimes based on a distinction between proprietary and governmental functions. Proprietary functions are generally held to be subject to zoning restrictions while governmental functions are not. The latter are those imposed on a municipal corporation by the State as that part of the State's sovereignty to be exercised by the municipality for the benefit of the general public—both within and without the corporate limits. Proprietary functions are the municipality's private rights as a corporate body exercised only for the advantage of the city and its inhabitants.

Thus, in the absence of specific exceptions by ordinance, the key question becomes that of determining if operation of sewage treatment facilities is governmental or proprietary. In a 1935 New York State case, a municipality was enjoined from erecting a garbage disposal plant in a restricted district on the grounds that it was performing a proprietary act. Therefore it was bound by the terms of its own ordinance prohibiting disposal plants. An opposing viewpoint is expressed in a 1969 Vermont case which held the construction of a sewage disposal plant to be a governmental function, therefore exempt from local zoning ordinances.

The issue where two political entities are involved also varies in outcome according to specific court rulings. A 1962 decision by the Supreme Court of Missouri upheld a county's zoning restrictions prohibiting construction of a sewage disposal plant by a city in a residential district

Monitoring of ground water should begin before a waste treatment facility is built in order to answer possible later complaints about water quality degradation.



Excavating for a drainage collection ditch disturbs water table close to the surface, raising question of ground water degradation.

of that county. The opposite result was reached the same year in a decision by the Supreme Court of Arizona, which held that operation of a municipal sewage disposal plant was exempt from the zoning regulations of another municipality in which the proposed site was located. Recognizing the distinction between proprietary and governmental authority, the court noted that the weight of recent authority appears to support the theory of sewage disposal being a governmental function.

Land treatment facilities may also be subject to private control measures where such operations have a detrimental impact on surrounding property. Our system of civil law which defines private rights provides a mechanism for accountability where one party's activities injure or infringe upon the rights of others.

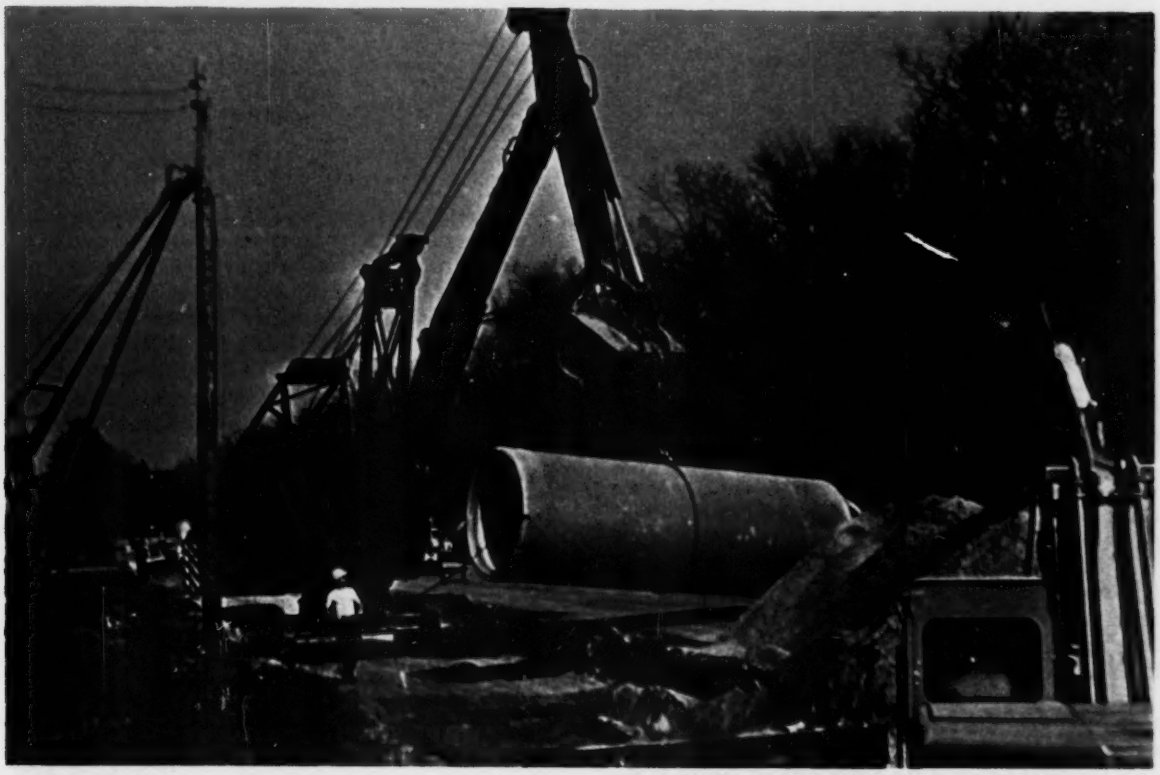
The concept of *private nuisance* is likely to be a central element in any legal conflict arising out of situations where land treatment facilities create conditions which unreasonably interfere with the use or enjoyment of other property. The mere displeasure of an adjacent landowner is not sufficient in itself. There must be substantial interference with a legally protected interest. The court can be expected to weigh the harm produced versus the social utility of the activity in question. Since the utility of wastewater treatment to the general public cannot be questioned, suits based on nothing more than a general objection to establishing such facilities almost invariably have been unsuccessful.

In most cases the courts will refuse to grant injunctions that would prohibit construction or force cessation of operations. The more common remedy is an award for compensable damages. However, a successful suit for damages must be based on a showing of injury greater than slight discomfort or annoyance. On the other hand, it is not necessary that an imminent danger to health exist or for the property involved to be made totally unusable.

The nuisance concept encompasses activities that create offensive conditions including unpleasant odors, loud noises and disease-causing insects. The courts recognize the right to collect damages where these conditions are caused by operation of sewage disposal facilities. Such damages can include compensation for property value depreciation and an award for personal discomfort.

The claim that a facility has been properly designed and operated is not likely to nullify the right to recover damages. Neither is *coming to the nuisance* a legal bar to asking for compensable damages. In other words, it does not matter whether the nearby property owner was there before or after the land treatment facilities were established. This principle has been applied to a variety of industrial or commercial activities established in undeveloped regions that were later encompassed by expanding urbanization. A 1951 Florida court decision indicates that this principle includes garbage disposal

This 66-inch force main will carry sewage from Muskegon, Mich., to a treatment area west of the city. Using underdrains protects the quality of ground water flows.



Consumptive use of wastewater may deprive downstream users of return flow.

plants, and therefore is likely to include sewage treatment facilities.

Ground Water Rights

Private rights in ground water may act as legal constraints on land application of wastewater where adverse effects result from alteration of water quality or natural flow patterns. Although land treatment is intended to reduce overall water pollution, any accompanying degradation of ground water quality may subject the operator to legal action by the users of that water. Ground water recharge may also damage other users by artificially raising their water table.

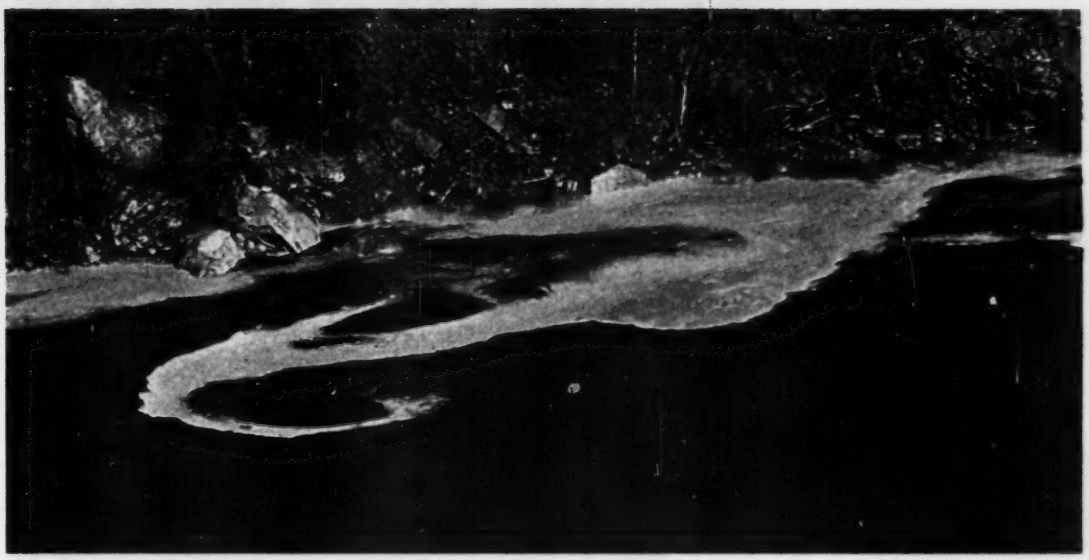
The right of the landowner to uncontaminated ground water has not always been recognized. In some cases the courts have been reluctant to impose liability where the pollution resulted from lawful uses of adjoining land. The justification for this attitude has been that such property injury could not have been anticipated. In other cases, however, the right to uncontaminated water has been upheld and liability imposed on those responsible for contamination.

In some of the latter cases the right to pure ground water has been viewed as an absolute right. In such instances, liability has been imposed on the party responsible for degradation of the water without regard to the reasonableness of the activity or the care with which the operation was conducted. Acceptance of this strict liability concept is increasing, thus making it easier for an injured party to recover damages.

One of the most difficult aspects of ground water pollution is establishing a cause-and-effect relationship between the polluted water supply and the alleged pollution source. Since direct evidence is often impossible to obtain, the courts have often accepted circumstantial evidence in such cases. The fact that ground water contamination suits are often initiated and decided with relatively imprecise data makes it appear desirable to begin monitoring ground water quality before operation of the site as a treatment facility. Background data will then be available for comparative purposes in the event complaints of quality degradation arise later.

Under certain circumstances the increased subsurface flow may reach adjoining lands and so raise the ground water level that agricultural or residential development is adversely affected. Underdrains constitute one method of mitigating both the qualitative and quantitative effects of these subsurface flows. However, a survey by the American Public Works Association indicates that only

Sewage billows into scenic river, marring both quality and aesthetic appeal. EPA-DOCUMERICA George Burns



4.9 percent of 122 disposal fields examined had underdrains. Designers of these disposal systems mostly relied on evaporation, plant transpiration and ground water recharge to take up the flow.[3]

There have been several cases concerning damage as a result of constructing reservoirs from which there was subsurface leakage. In an Ohio case the plaintiff based his claim on the concept that the defendant had committed a *trespass* and the court held that liability was absolute without regard to the defendant's exercise of *due care* in building and maintaining the dam and reservoir.

An earlier Florida case was similar in situation. The court found in favor of the injured landowner on the basis that damming a stream and causing an increase in ground water levels that produced injury to the property was *unreasonable.* This case also addressed the question of escaping liability due to the fact that the dam was built under the authority of the U.S. Government. The court held that authority to erect the dam did not justify an unreasonable use that affected the rights of others.

An analogy to the case of land disposal could exist here, since the Federal Government is likely to provide much of the future project funds for such undertakings and, in so doing, gives its implied consent to a land disposal project.

Surface Water Rights

The major water doctrines prevalent in the United States—riparian and appropriative—qualify surface water rights apart from other types of real property. The difference lies in the fact that the *use* of the water, not the water itself, is the subject of the property right in-

[3]EPA, *op. cit.*, p. 73.

volved. The riparian doctrine recognizes a property right to the water only when the use of it is *reasonable* in terms of allowing others who share ownership of streambank property to have an equal right to the water. Under the appropriative doctrine, a property right does not even arise until the water has been put to *beneficial use.* There is general agreement that beneficial use and reasonable use both carry economic as well as legal connotations.[4]

Application of municipal sludges and effluents to land constitutes an *add on* with regard to water use. Although this recycling has most of the attributes of irrigation, the rate of application and other parameters are defined not in terms of optimum irrigation but of obtaining improved water quality. Therefore, the question must be asked as to whether this recycling of wastewater is a beneficial or reasonable use under our current water law doctrines. While improved water quality may well be accepted as a national goal, should it be obtained at the expense of property rights established by State water laws?

The general rule in those States following the appropriative doctrine[5] is that, once established, a water use will remain substantially unchanged unless change can be accomplished without detriment to other appropriators—including those with junior rights. Thus a conflict arises where a proposed modification in use involves a change from a nonconsumptive to a consumptive use, since the latter depletes the source of flow by not returning the water to its original channel.

Land application of municipal wastewater would appear to fall into this category of change. Irrigation is a greater consumer of water than traditional municipal use. In fact, the appropriator located immediately downstream from the previous point of waste discharge may be denied all use of the return flow that existed before irrigation was started.

The limited precedents set in this area create doubt about how well the interests of junior appropriators will be protected. A recent case in Colorado ended with the court drawing a distinction between a change in the point of diversion and a change in the point of effluent return. The court held there is no vested right in the maintenance of the same point of return of irrigation wastewater for downstream appropriators and—in the absence of bad faith, or arbitrary or unreasonable conduct—the same rule applies to sewage effluent from a municipality or sanitation district. Even though this case had a strong dissenting opinion, the majority viewpoint may permit land application of wastewater without legal accountability to those whose downstream water rights are adversely affected.

A majority of the States operate under the riparian doctrine. This doctrine is based on the simple premise that whoever owns land traversed by or bordering a flowing stream may make *reasonable* uses of its waters that do not interfere with other property owners having a similar right. After making a reasonable use of the water for his own purposes, a riparian must return all the surplus to its natural channel before it reaches downstream riparian owners.

The amount of acreage required for land disposal makes it unlikely that land so used would be situated such that return flows would reach the stream of origin at a point above the property lines of all lower riparians. Therefore land application is likely to violate the rights of other water users on the stream.

The situation is complicated further where the return flows ultimately find their way to a different stream. Such interbasin transfers generally are not recognized under the riparian doctrine. There is no cause for legal action in the absence of actual injury to another landowner's rights. Therefore, legal obstacles may not exist where there is a water surplus. Where a surplus does not exist, land application could be excluded in some riparian situations unless special provisions are made to either acquire the water rights to those affected or to return the used effluent to a point above the lower riparian properties.

Since the riparian doctrine is concerned with protecting the quantity and quality of the flow on behalf of abutting landowners, it automatically protects the natural water course itself. Included in this protection are the stream's scenic attributes, associated wildlife habitats and instream uses, such as fishing and recreation. Where the recycling of waste effluents significantly modifies the stream regimen, these other attributes may become the basis of a legal action by *any* affected citizen.

A significant factor in this regard involves today's more liberal court interpretations on such questions as the right to sue and class actions on behalf of groups possessing a common interest. Opening the courtroom doors to such actions greatly expands the liability potential. It thus becomes evident how carefully surface water problems must be dealt with when designing land disposal systems.

The ultimate test of feasibility for a given installation may well depend on consideration of the potential legal constraints that have been discussed. Failure to recognize these constraints is likely to produce problems during the operational stage. The result will be inefficiency and frustration in applying the land disposal concept. Only when these constraints are incorporated into the total design framework—from the initial planning stage—can the potential of land disposal be realized effectively. ■

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[4]See authors' "Meandering Water Rights," WATER SPECTRUM, Vol. 5, No. 1, Spring 1973, p. 37.

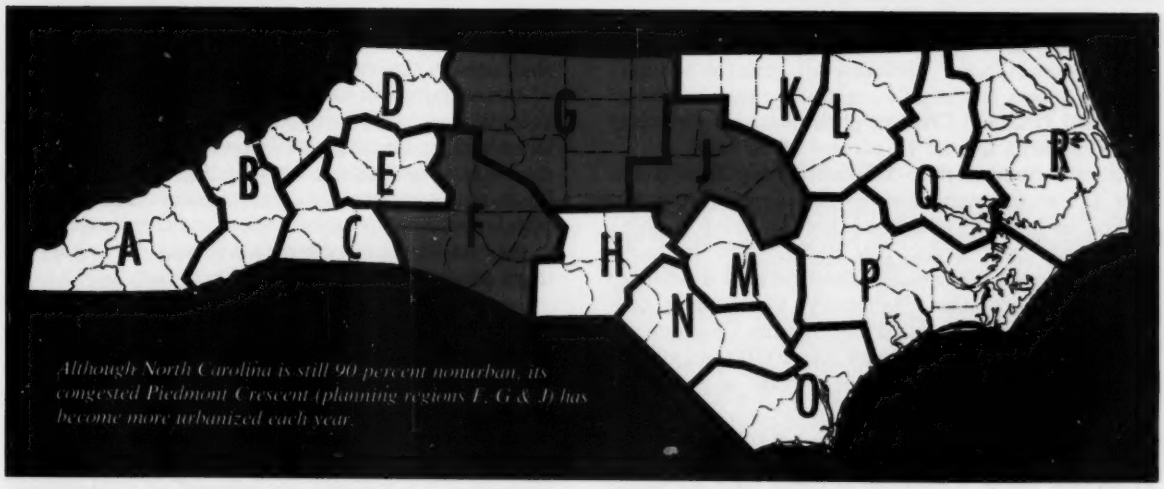
[5]Many western States find this doctrine better suited to their limited water resources than the riparian doctrine.

Water Spectrum articles during the past year have discussed existing and pending land use programs, with general implications for water resource management. This article gives a grass roots account of a State's emerging land use system and the specific land use problems which the program addresses.

A STATE'S APPROACH TO LAND USE

by James R. Hinkley
Assistant State Planning Officer
for Natural Resources
Office of State Planning
North Carolina Department
of Administration

We need to institute a land stewardship system whereby we will preserve and maintain—whereby we will recycle—whereby we will minimize the inordinate consumption of land.



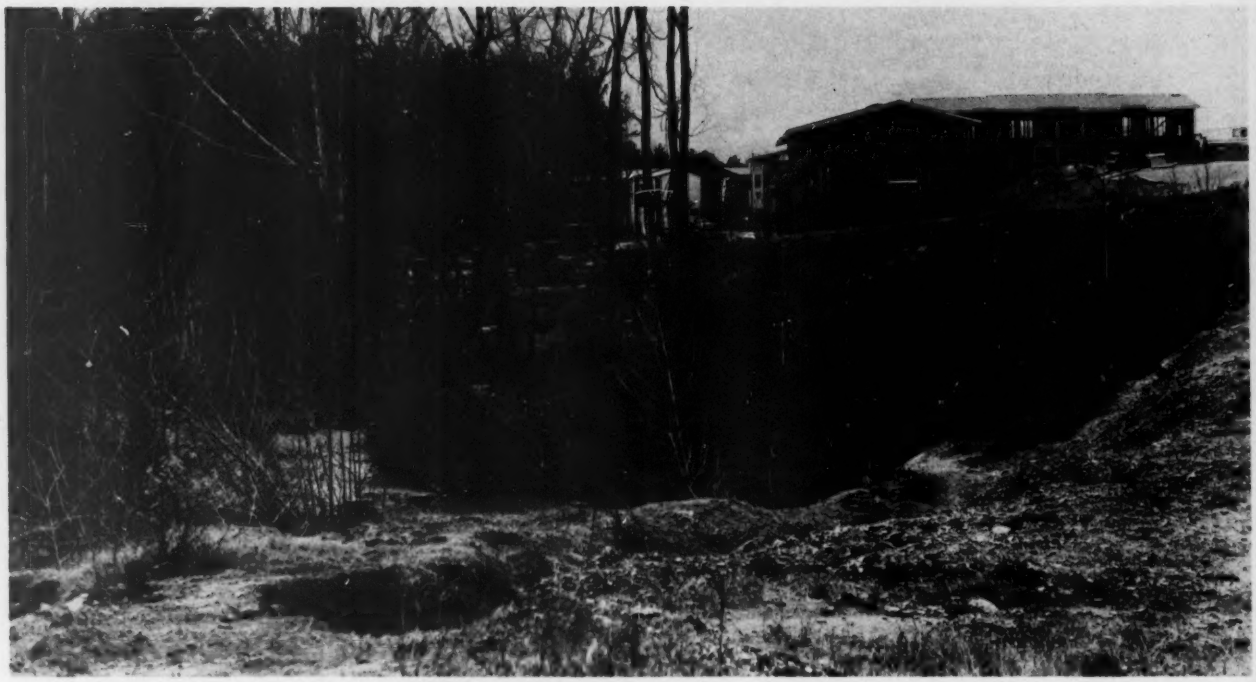
Although North Carolina is still 90 percent nonurban, its congested Piedmont Crescent (planning regions F, G & J) has become more urbanized each year.

Although it is coming, North Carolina has yet to feel the brunt of congested urban life. Until recently, growth and development have moved more slowly in North Carolina than in many other States. We have been able to watch our sister States struggle with the phenomenon and we consider ourselves fortunate.

The irony of all this is that we have been resting on our laurels; we are unprepared for what we know is coming. We are letting happen to North Carolina what happened to our Nation. And we are letting it happen at a much quicker pace—advances in building technology, growing affluence, and the surge of migration to the southeastern section of the Nation all contribute to this increasing rate of development. New development, while considered an economic boon for some localities, has created new problems instead of alleviating old ones.

When we make a demographic comparison, we not only find that North Carolina ranks 12th in population among the States, but that its dispersion pattern is more uniformly broadcast among small communities and rural areas, which contain 55 percent of the State's people. Thus, our urban population is only 45 percent compared with a national urban population pressing 80 percent. We are considered by some to be the most rural State in the Nation.

Most urban North Carolinians reside on about 7 percent of the land, while the national urban population lives on 10 percent of the land. However, in the



Disregard for planning brings unnecessary destruction of nearby stream as housing development encroaches upon the flood plain.

congested Piedmont Crescent of the State, 47 percent of urban residents live on 16 percent of the land.

All other States in the 3- to 7-million population range have at least one major metropolitan concentration of a million or more people. Some have as many as three. North Carolina's largest city is Charlotte. Its three-county standard metropolitan statistical area is estimated at 567,000 population. Nationally, Charlotte is considered only a medium-sized city. Besides Charlotte, we have only three other cities with over 100,000 population and only four cities between 50,000 and 100,000 inhabitants.

Although 90 percent of the State is still nonurban, the conversion of land to urban use from 1958 to 1967 was 83 percent, nearly a doubling of urban land use during that period. What has been happening in the last 5 years may have doubled again this amount. Multicounty planning regions F, G and J, essentially our urban Piedmont Crescent, have increased their composite populations by a million inhabitants since World War II. We have let our central urban cores deteriorate while we have gone about adding senselessly to our urban geographical base.

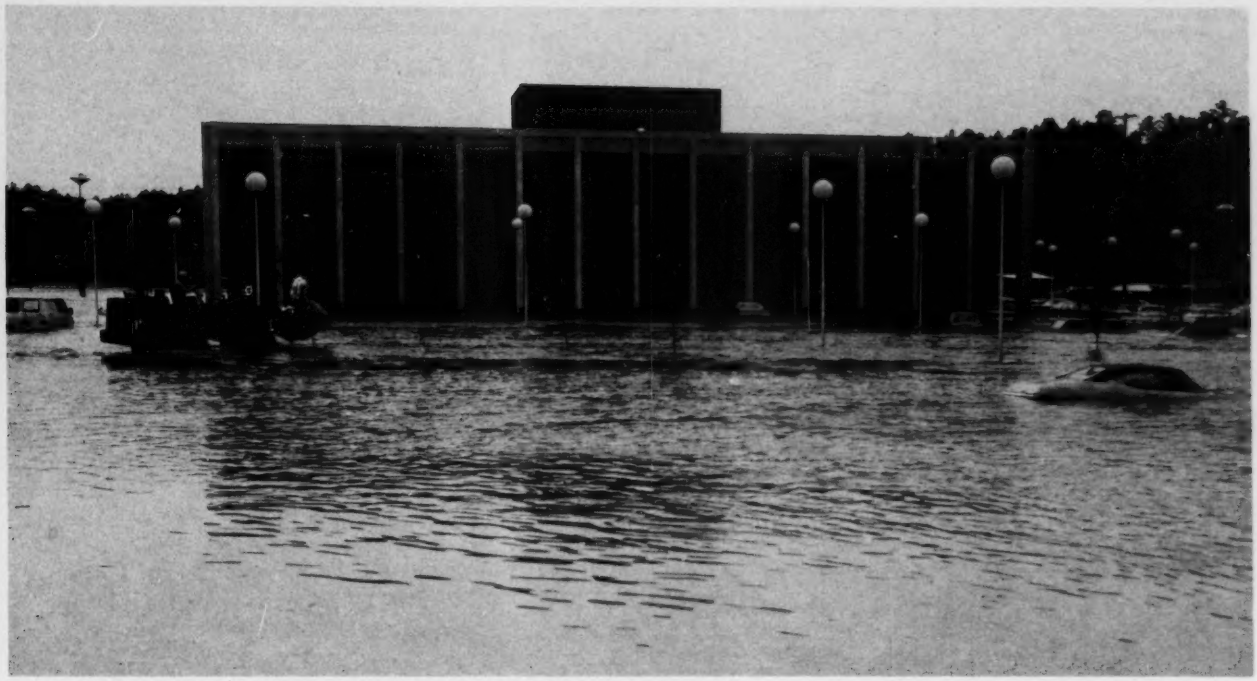
Our population in North Carolina by the year 2000 may be in the neighborhood of 7.5 million—an increase of 50 percent over the 5 million recorded in 1970. For us to assure that we can accommodate these millions, we shall need to replicate (replace and duplicate) by the end of this century—in just 26 years—every dwelling unit, every school, every hospital, etc., which has been constructed since the State was first settled. Wherever one of these homes or facilities stands today, we shall have to build two somewhere to accommodate the projected population. Some prognostications indicate that building in the next 10 years in America will equal that which has taken place in our first 200 years.

Some Prevailing Attitudes

While we are planning as never before, land use plans are being shelved and disregarded. There are too few communities which stick to their plans. It is apparent as one travels across the State that one cannot distinguish the planned communities from the unplanned ones. The visual clutter, the traffic jams, the flooding of businesses and homes, and the general inconveniences are not a result of planning, but a result of no planning or, more accurately, the disregard for planning.

Most planning boards do little or no planning. Their time is normally consumed in deciding zoning issues—approving subdivision plats—and presiding over public hearings. Agendas are glutted with such items. Planning is caught up in remedial, day-to-day problem solving, epitomized by zoning and subdivision transactions often not within the context of a land development plan. If a plan is used as a guide, nearly all deliberations have to do with some sort of attack or defense of that plan.

The planning board's role changes on the frontiers of growth. Here, on the urban fringe, the name of the game



There would be little question about building shopping centers on flood plains if State policy prohibited it.

changes to the attitude so often expressed as "We can't stand in the way of progress." It is here that all kinds of amendments to existing plans and zoning are allowed, whether sound or not, to accommodate development pressures.

Faced with this attitude, professional planners have to compromise their plans while they are still on the drafting tables, in the hope that what they propose might meet with some degree of approval. They have had to resort to agreeing to adoption of mediocre, compromise plans that would be palatable to the local planning and legislative bodies.

Local understanding of land use planning is another attitudinal problem. Planning and zoning are sometimes considered to be synonymous. The fact is that planning should precede zoning. *Planning is the schematic for development and conservation; zoning is the legal tool for implementation.* Far from insuring proper development, in many places zoning institutes and perpetuates poor development—because it is ill-conceived, haphazard and not utilized according to sound development principles. Communities and counties that have placed zoning in force illegitimately without prior planning are now having to cope with the results. These include strip commercial districts along major highways, incompatible land use mixtures, the inordinate use of floodways, loss of valuable open space, etc. Illegitimate zoning is a wolf in sheep's clothes.

Changing Attitudes

Increasing citizen concern has influenced all levels of government to undertake more serious consideration of all aspects of land use planning. There are many examples.

In Fairfax County, Virginia, the County Board of Supervisors has imposed a staged moratorium on sewer connections and drastically cut approval of requests for higher density rezoning. The aim is to bring development in the county to a virtual halt by 1975.

In Ramapo, New York, new construction is prohibited unless the builder provides adequate sewers, parks, roads and other municipal services. An urban services point system for timed development has been instituted.

In Boulder, Colorado, the greenbelt program adopted in 1967 established a limit, called the Blue Line, beyond which the city will not provide water for development.

In Florida: Dade County building moratoria have been used to control development; and a growth policy with population limitations is part of a revised land use plan. Boca Raton's electorate has put a 40,000 limit on dwelling units, with a legal limit of 100,000 inhabitants.

In Ithaca, New York, KISS has been formed to "Keep Ithaca Sorta Small."

And in North Carolina:

Avery and Transylvania Counties have adopted new local ordinances which specify that certain types of development shall require environmental impact

Existing homes along this beachfront are protected by a berm and dune project constructed by the Corps. Future building, however, has been restricted to that part of the beach beyond the new berm and dune (at top of photo).

statements before approval. Holden Beach has the same type ordinance.

Currituck County instituted a 15-month moratorium on approval of new subdivisions in 1972; thus providing time for land use planning and replatting of gridiron subdivisions which have laced the Outer Banks with total disregard for topography.

Wake County has formed Wake Environment, a coalition of concerned citizens, environmentalists, developers, and politicians—an organization dedicated to sensible growth.

A statewide Land Use Congress was formed 4 years ago under sponsorship of the Soil Conservation Society.

In these examples, and in legislation before the General Assembly, can be seen a clear trend. The relationships between land uses and environmental, economic and social objectives are being recognized.

Root Problems

Many inherent problems complicate North Carolina's land use planning. Among the most apparent are:

Belief that man is totally within his rights to do what he pleases with his land. When the early settlers cut trees and cleared land in order to build the farm, there were few land use alternatives to be weighed. The swinging of their axes was driven by a single-mindedness—survival in the wilderness. Today we are no longer free to enjoy this single-mindedness—we have conquered the wilderness. The affluence which has brought increased benefits has also brought increased responsibility. When we decide to use the land to our own benefit, we must realize that whatever we do is going to have an everlasting effect on those beyond our immediate family or community.

Thinking "newer is better." The widely accepted belief that it is cheaper and easier to build anew and toss out the old has led to urban sprawl and inner city decay. Once the land has been developed, the loan amortized, the depreciation reaped—man moves on to new and more challenging fields. Our downtowns deteriorate and dilapidate while new subdivisions explode on the horizon. We need to institute a land stewardship whereby we will preserve and maintain—whereby we will recycle—whereby we will minimize the inordinate consumption of land.

Land is purely an investment commodity. Senator Gaylord Nelson said at a hearing before the Senate's Interior and Insular Affairs Committee that allowing capital gains on land is a disgrace. We need to begin thinking of land as a statewide resource for all, and regarding it less as an investment commodity for the few.

Good farmland is excellent for residential, commercial and industrial development. Such land has good drainage, is fairly level and is already cleared—all the physical attributes required for easy urban development. We have settled where our farmland lies. Croplands in the vicinity of any growing city lie in wait of eventually being converted to urban land uses. Community planners

Zoning is a legal tool that could prevent construction of more shops and homes on this flooded street.

Low-lying Farmers Market near Raleigh is converted into swift flowing creek by June 1973 floodwaters.

Once in place, beachfront structures may be protected to some degree by sea walls, such as this one preventing further erosion at Carolina Beach near Wilmington. Below-Ocean waves lap at cottage doorsteps beyond wall's end.

claim that half our prime cropland is in just this danger. We must somehow deal effectively with this conflict of use. A differential agricultural land tax approach adopted by the General Assembly in 1973 is a first step in this direction.

Conflict between the fears of environmentalists and the true need for development. On the one hand we know that we cannot stop development because our population must be served; it must be recognized that urban growth is legitimate and inevitable. On the other hand, it must be recognized that land is a precious resource. Resolution of this conflict is in how we grow: We must stymie unchecked sprawl and accommodate needed new uses where deterioration and dilapidation prevail. Our stewardship of the land must incorporate a recycling element into land use planning.

Lack of intergovernmental cooperation. Among the conditions that aggravate this situation are:

- Lack of ability to guide growth for legal reasons. Community growth normally flows beyond municipal limits into unincorporated suburban areas. In recent years North Carolina municipalities have been empowered to exercise extraterritorial rights which allow them to control land use, guide development and administer regulations up to 1 mile beyond their corporate limits; larger cities have the option of enforcing codes up to 2 or 3 miles beyond their limits. To do so they must receive permission from their home counties, the traditional enforcers of zoning, subdivision, building, housing, plumbing and electrical codes in county growth areas. Some counties, however, are justifiably skeptical, from poor examples already set, of the cities' ability to deal properly with growth and development problems; though the counties themselves may have demonstrated even less ability to handle new development. Hence, where growth is most dynamic is where guidance is the weakest.
- Difference in structure of local units of government. Municipal units are generally more sophisticated than county units. County commissioners lack direction and control over several county service divisions and departments; and smaller towns do not have full-time executives. Often there is no counterpart department in one unit to match that in the other. And where there are no hired managers and planners at the executive level, many detailed technical problems common to both units are handled without benefit of intergovernmental cooperation.
- Poor communications. There is a general lack of knowledge among the various local units of government as to what each is doing. Subdivisions crop up, new schools are sited and major service facilities are located—all without the benefit of mutual consultation. The daily newspaper may be the prime means of communication in some instances.
- Pettiness. Intergovernmental competition, evidenced by pride and jealousy, tends to keep city and county units at arm's length at the planning table. Common objectives are lacking; responsibilities for ill-advised urban growth are sloughed off.
- "Bigger is better." The largest city or county—the fastest growing—has always held the public interest. Newspapers each month list the top 10 cities in value of construction. The "top 10" list should pertain to quality rather than to quantity.

Planning Partnership

Over the years the State of North Carolina has delegated the guidance of land development to its 470 municipalities and 100 counties. By adoption, and subsequent amendment, of a package of bills informally known as local planning enabling legislation, the General Assembly has empowered local governments with the legal tools of zoning, subdivision regulations, floodway regulations, sedimentation control, and housing, plumbing, electrical and fire inspection.

These development guidance tools have generally not been used to advantage by local governments. The enabling legislation which delegates the power is in no way mandatory. Thus, only a relative few of the State's active municipalities and counties have exercised fully their options for guiding growth and development.

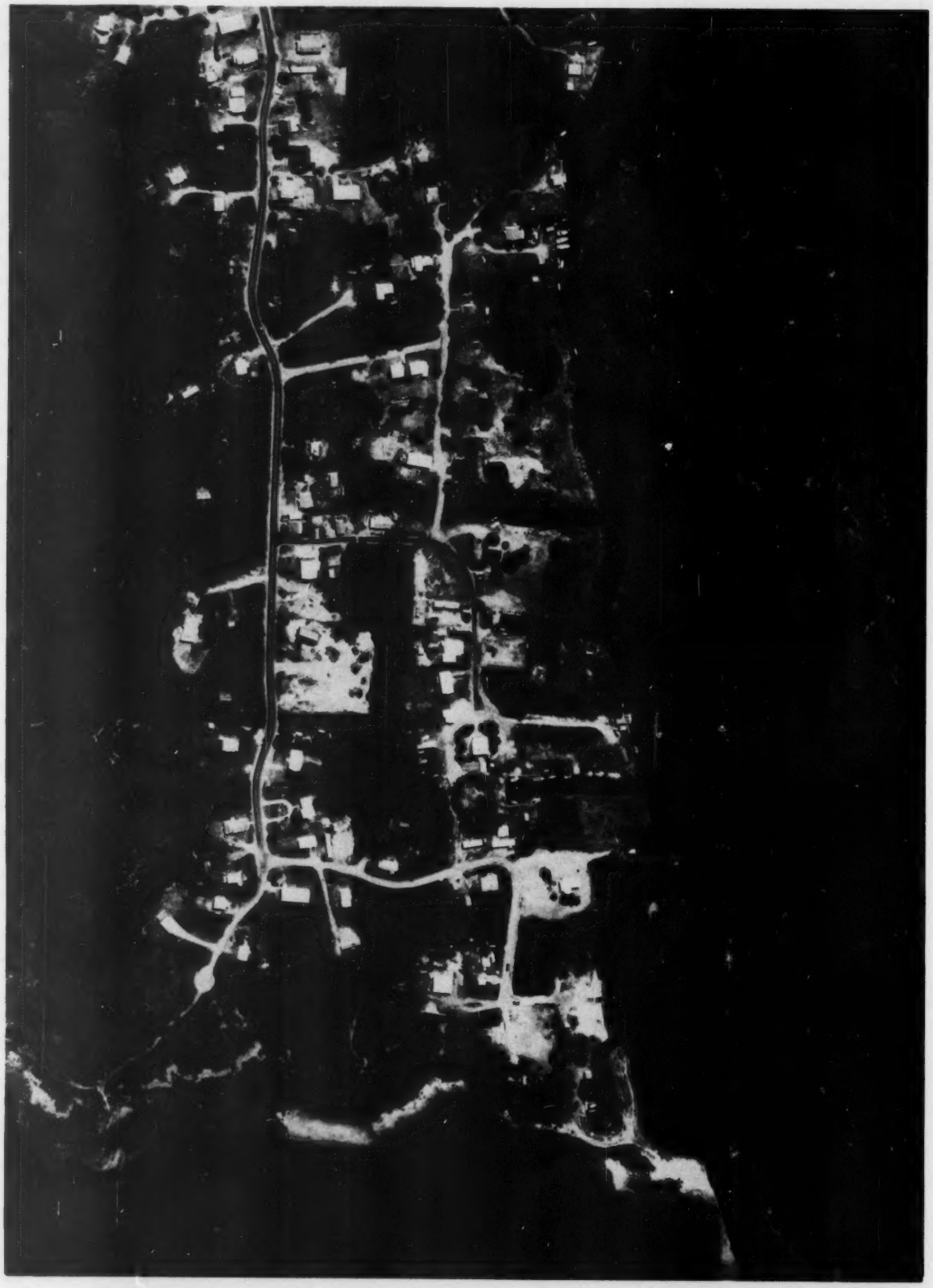
In the last several years local governmental units in the State have formed regional councils of governments and also planning and development commissions. In May 1970 former Governor Robert W. Scott announced the geographical delineation of 17 multicounty planning regions in North Carolina for the purpose of coordinating, and to minimize duplication of, the planning being done at the various levels of government. As of October 1973 a Lead Regional Organization (LRO) has been recognized by the State for each region and empowered by its sponsoring units to perform comprehensive planning. Though local units may delegate to their LROs any powers they themselves hold—except the powers of taxation and eminent domain—to date no powers have been granted to effect land use guidance and control.

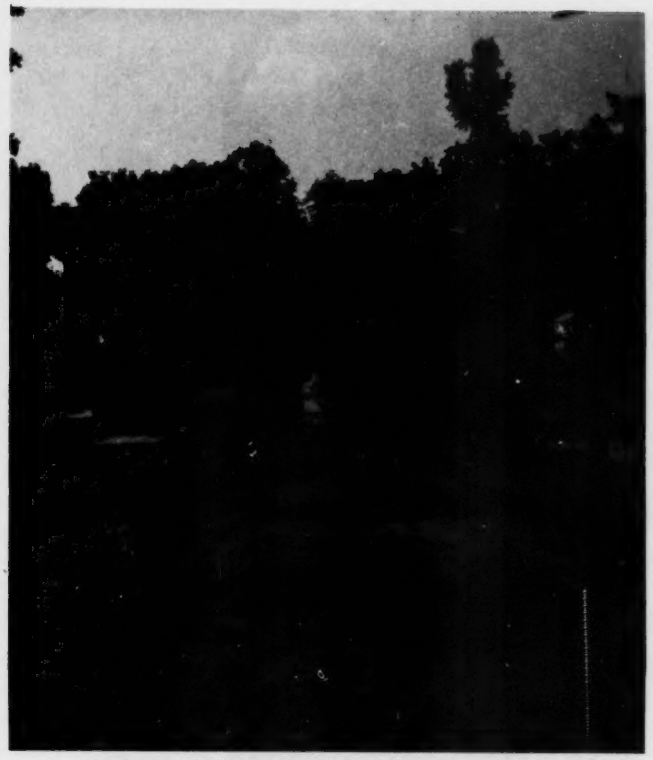
As noted earlier, North Carolina has passed the responsibilities of guiding growth to local governments. Realistically, this assignment amounts to an abdication of responsibility. The guidance and policy direction coming from the State level has been limited to stipulations as to establishment, membership and administrative procedures of planning and zoning boards.

Conversely, the State has provided a pool of technical assistance for local units of government of fewer than 50,000 inhabitants. The Division of Community Services of the Department of Natural and Economic Resources has provided staff and overhead for local planning and management assistance for 16 years.

Through the 5 regional offices of this division, some 50 able professional planners have been made available to numerous counties and cities. The program has been financed through the 701 program of the U.S. Department of Housing and Urban Development (HUD). Local units pay a fourth to a third of the cost and HUD foots the remainder. Local units are also assessed a percentage of the total project cost to help defray the State's overhead expenditures. Thus, the State has been able to influence local planning through the provision of high

Aerial view of Hatteras Village on Outer Banks typifies pattern of encroachment onto estuaries of North Carolina's coastal lands.





Bulldozed roadbed pushes its nose through an obviously flood prone area, disrupting nature's drainage system.

quality control by professional planners. With 199 municipalities and 73 counties involved in the program since 1959, Community Services has rendered a great contribution to North Carolina.

Linking Local—Regional —State Planning

Local government possesses the necessary power to guide growth. The problem is one of political sensitivity. Local decisionmakers should be able to rely upon a meaningful body of policy and direction from the State to guide land use to alleviate sensitive issues. For instance, there would be little question about building shopping centers on flood plains if State policy prohibited it.

To insure the proper conservation and development of the State, unilateral land use planning must become multilevel land use planning. There must be a vertical integration of the planning process. A strong linkage between local, regional and State planning needs to be developed and nurtured. The bond would necessarily include policy and financial assistance from the State, the delegation by local governments of some land use implementation tools to regional planning units, and a much more concerted effort by local government to provide proper growth direction. For the integration to be tolerable for all units, mutual plan adoption procedures will need to be incorporated into the multilevel planning machinery.

Further, there must be a horizontal integration of the planning process. Local units of government will need to establish intergovernmental linkages (city-city, city-county, and county-county). Planning for land use, growth and development must become a cooperative effort with the respective regional units serving when needed as brokers, expediters, and arbiters in local cooperative planning efforts.

In anticipation of new land policy legislation by the General Assembly, Governor James E. Holshouser, Jr., has appointed a State Land Policy Council by executive order. Chaired by Secretary of Administration William L. Bondurant, the Council also includes the Secretaries of the Departments of Human Resources, Transportation, Commerce, Revenue, Natural and Economic Resources, Agriculture and Cultural Resources. Lieutenant Governor James B. Hunt, as President of the Senate, and Speaker of the House James E. Ramsey are participating by invitation of the Governor. Core staff is being provided by the Office of State Planning, and all State agencies are on call to provide further assistance.

The Council reports to the Governor semiannually and is charged with the development of a management system for State-owned lands and the formulation of a statewide land policy. The latter's heart will consist of a number of policy statements; its backbone will include ongoing analyses and projections based on an information system of land use data in statistical, text and cartographic form.

Land policy formulation will also entail an evaluation and analysis of existing land use laws, with recommendations for possible improvement or modification. It will establish criteria for identifying areas of particular public concern and for siting key facilities. It will create a classification system to establish standards for development, production and conservation types of land. It may actually designate certain lands of statewide interest for classification. Other areas which the Council may need to explore include annexation procedures, utilities extension policies, expanded differential land taxation and subdivision regulation.

The legislative and executive levels of State Government are taking actions geared to rectify and improve the existing status of land use planning systems in North Carolina. Moves are being made to guide growth, to manage change, to steer development in accordance with sound planning and to assist local units to come to grips with expansion pressures. These actions, along with the changing attitudes of the citizenry, will insure the preservation and improvement of the amenities now enjoyed by the people of North Carolina. Times are changing. Attitudes are changing. And our chances for the better life will be improving with the creation and activation of a State land policy. ■

Cabin Creek

An accumulation of unpaid social and environmental costs in Appalachia.

by Riley Q. Baumgardner and Dan E. Steiner

Cabin Creek is a small watershed in the mountainous country of Kanawha County, W. Va., not quite as far from the State Capitol at Charleston in miles as it is in economic and social lifestyles. While Charleston exhibits the amenities of the modern metropolitan area, Cabin Creek only presents vistas of deep-mine refuse and strip-mined coal fields that produce energy which goes elsewhere in the Nation at the expense of yet to be paid local costs.

Section 233 of the Flood Control Act of 1970 authorized the Corps to review the effects of strip mining operations upon our navigable waters and their tributaries and then recommend appropriate measures to alleviate the adverse conditions found.

In making its first appropriation, Congress asked for a pilot demonstration of a reclamation project that might be undertaken by the Corps. This assignment was given to the Huntington District of the Ohio River Division. Huntington recommended the drainage basin of Cabin Creek in the Appalachian region as a representative problem area suffering from strip mining effects.

Its very proximity to metropolitan Charleston even highlighted the sharp economic, social and environmental contrasts between the two areas—contrasts known to be prevalent throughout Appalachia. We realized in making our selection that all of these implications would have to be considered in addition to our usual areas of concern—the drainage basin and its related land resources. Therefore, our feasibility study for improving the Cabin Creek Basin would have to take us beyond the usual range of most Corps projects.

History

Early development of Cabin Creek consisted of an agrarian subsistence level economy. Native farmers had no understanding of the significance and value of the coal under their lands. Their mineral rights were sold for unbelievably low prices.

In time the speculators were followed by railroad builders who introduced the first of many changes in Appalachian lifestyles. Completion of the railroads stimulated rapid mine openings and traumatic changes. Company built coal camps sprang up throughout the valley with labor imported from other areas, often directly from southeast Europe.

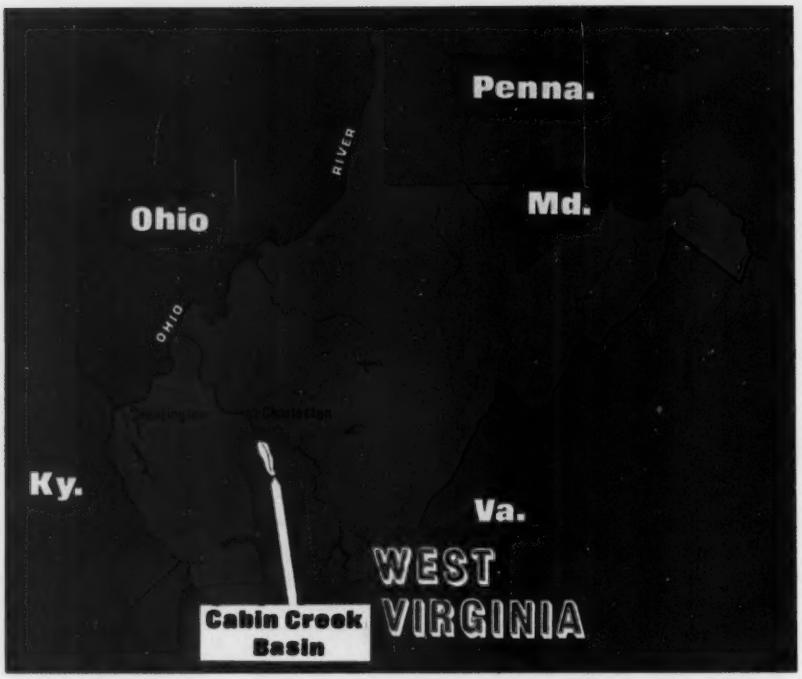
These increasing demands for coal and a tightening of immigration laws created a labor shortage and the coal mining camps were at least partly upgraded by the mining companies in order to attract the needed manpower. In some cases the extent of this effort was surprising. One isolated company-developed community in the upper parts of Cabin Creek even included a swimming pool, library, bowling alley and small theater. Concurrent unionization and higher wages provided the highest standard of living ever enjoyed by the area.

A major economic and social change swept the area in the wake of the Great Depression. This was followed by consolidation and mechanization of the mining industry during and after World War II. In addition to sharp declines in mining-related employment, the changing nature and role of the mining company from a former provider of community amenities to a now distant (often out-of-State) profit-oriented employer was of major impact. Company-owned housing and community properties were sold to outside individuals and real estate companies. The social structure which had developed around formerly plentiful employment, comparatively high wages, and company-owned towns simply disintegrated.

A society which had never had to work together to formulate and accomplish its community objectives was largely incapable of effective action. Moreover, limited employment opportunities motivated the area's most talented and capable young people to migrate to more promising areas. This left a residual population consisting of those least equipped to solve community problems.

The general degradation of the area was further aggravated in the 50s and 60s by a major increase in the surface mining of the coal. Ironically, the environmental degradations associated with the new, rapidly expanding surface mining industry were not offset by economic improvements in the Cabin Creek area. Royalties accrued primarily to nonresident interests and resulting employment opportunities were mostly for those skilled heavy equipment operators who had no need or desire to reside in the Cabin Creek area itself.

Mr. Baumgardner is Chief, Flood Plain Management Services Section, and Mr. Steiner is Chief, Water Resources Planning Section in the Planning Branch, Engineering Division, Huntington District.



Cabin Creek's proximity to the State capital in metropolitan Charleston only strengthens the economic, social and environmental contrasts between them.

Today

Given its recent history, we were not surprised by the present conditions in Cabin Creek. What development there is consists of small unincorporated communities lying alongside a polluted, debris-clogged stream. Population in the Cabin Creek area is about 5,000—a sharp decrease from the boom years of the company town era, vividly revealed by the skeletons of aged buildings overgrown with weeds and vines. Today there are few public services of any kind in the narrow hollow carved by Cabin Creek and no public sewage or water supply services. Public oriented service industries are limited to a few small grocery stores, gas stations, and a State liquor store.

Mining continues to be the predominant economic endeavor. Coal production averages about 3 million tons per year and recoverable coal reserves are estimated to exceed 150 million tons. About 55 percent of the area's coal production is from underground mining operations. The remainder comes from surface extraction techniques.

A significant sector of the resident labor force is either unemployed or underemployed, with unemployment averaging about 8 percent. About 40 percent of the work force is engaged in mining-related activities. An additional 40 percent is employed outside of the area, generally in low paying service industry and custodial type jobs in the nearby Charleston area. Median family income of about 25 percent of the population is at or below the $3,000 per year level.

Housing is typically old, single-unit dwellings with an average structural value in the range of $5,000. Only 60 percent of the housing stock is owner occupied. The remaining 40 percent is in absentee ownership.

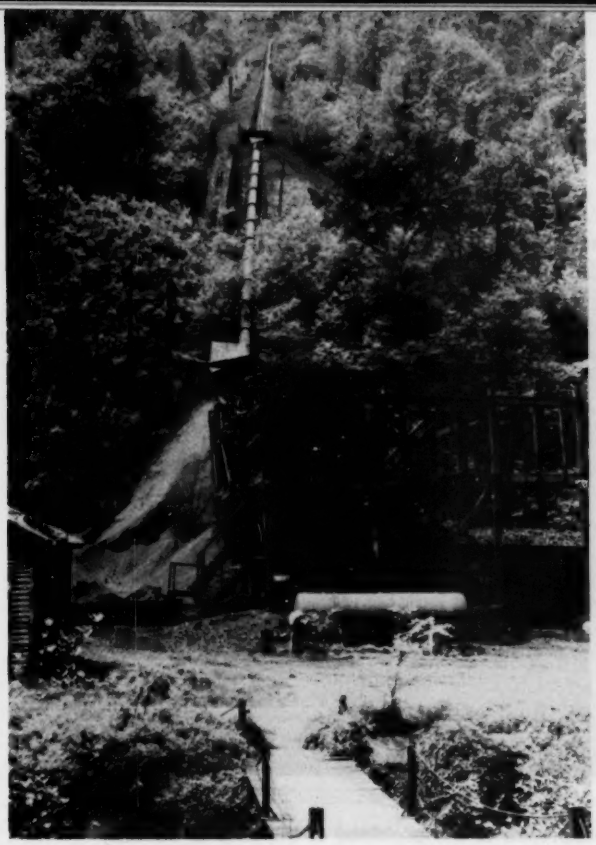
Land use in the 73-square-mile watershed is dominated by a combination of topography and mining. Though as much as 96 percent of the land consists of steep slopes, up to 17 percent of the area has been disturbed by mining and timbering activities. The resident population is located on about 2 percent of the narrow valley land, nearly all of which is flood prone.

The sustained exploitation and degradation of the area has resulted in a proliferation of water and land management problems. Among the major ones are:

- About 6 million tons of sediment are set in motion annually in the watershed.
- A 50-year flood would inundate the 600 homes and 50 churches, schools and businesses.
- Over 40 separate source areas of acid mine drainage have been identified.
- Raw and inadequately treated domestic sewage enters Cabin Creek at virtually all community areas.
- The domestic water supply is generally inadequate and often unsafe.
- Recreational facilities range from nonexistent to totally inadequate.
- Related problems include landslides, environmental degradation and lack of community facilities.

Rehabilitation

Of singular interest to the study group is the fact that solutions to the area's problems do not involve significant new technology. The unstable land areas and related problems can be solved by regrading, terracing, drainage diversion, and revegetation. In conjunction with land stabilization, sediment control can be accom-



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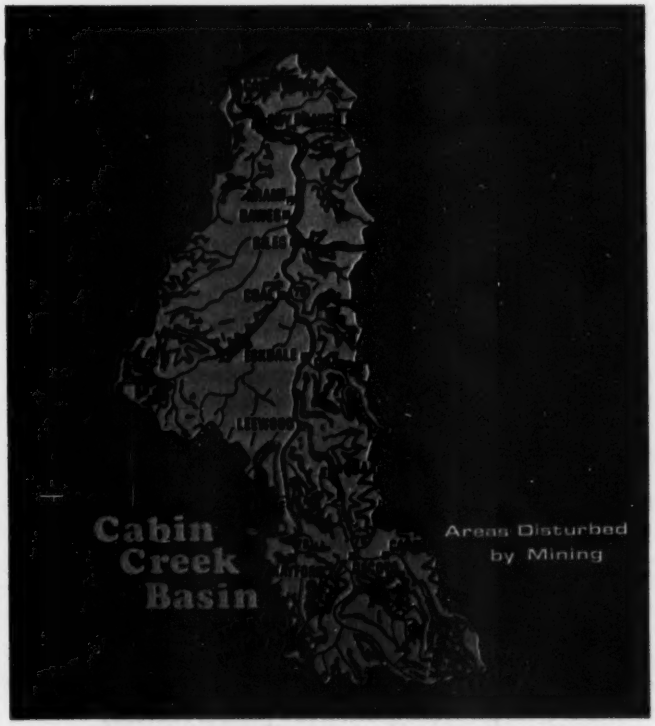

Some 17 percent of the watershed has been disturbed by mining and timbering activities.

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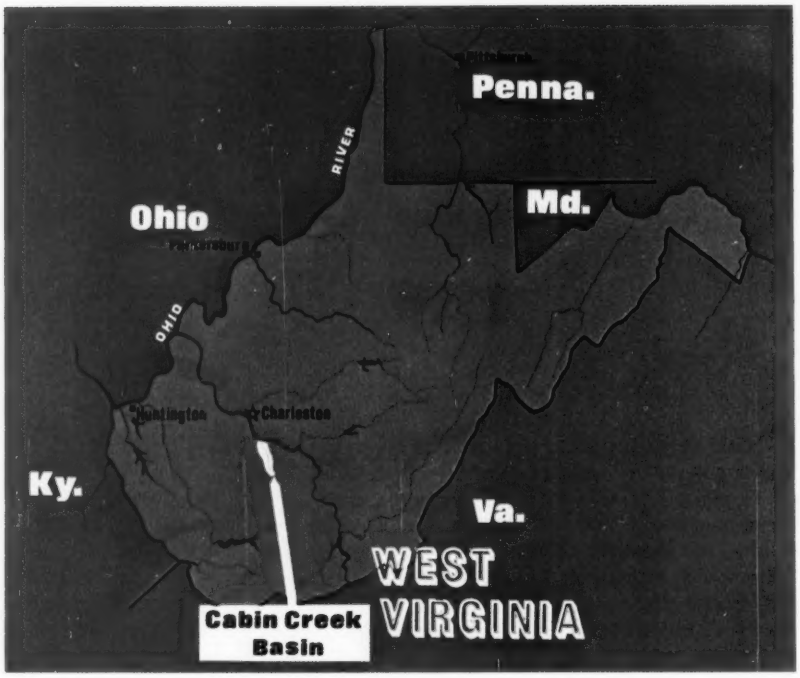
Reservoir storage, channel rehabilitation, flood-proofing of structures, and other nonstructural flood plain management measures afford opportunities for flood damage prevention.

An attack on water quality problems could include domestic waste collection and treatment systems, coupled with eliminating major acid mine drainage problems at their respective sources and possibly even treating the drainage in more limited problem areas. Alternative solutions to water supply problems include the rehabilitation and expansion of existing systems or the development of a new regional system for the valley.

Recreational needs of the populace could best be satisfied by community parks oriented toward day-use activities. In addition, establishing a managed public hunting area would be responsive to the kinds of leisure activities preferred by many of the area's residents.

Other desirable improvements would include solid waste collection and disposal, improved fire and police protection, removal of dilapidated buildings, improved roadways, and a general cleanup of the area.

We recognized that structuring and implementing such an extensive rehabilitation program would depend on effective coordination and communication with a diverse



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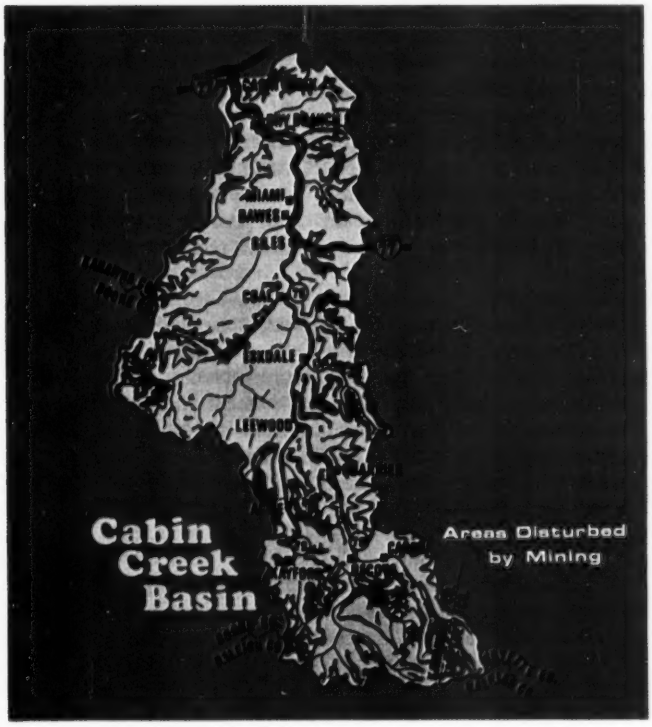

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Largest coal refuse or "gob" pile in Cabin Creek watershed builds up along Abbott's Hollow, impounding mine drainage in acid water ponds at bottom of hollow.

Once covered by vegetation, a barren mountain top exhibits telltale benches left behind by strip mining operation.

array of affected interests. These interests were identified in three broad categories:

- Residents of the area.
- Governmental agencies.
- The mining industry.

A series of informal meetings with area residents and community action groups was a first order of business and was continued throughout the feasibility study. While this informal meeting process provided for an interesting exchange of news and a sense of local priorities, it was apparent we were reaching a comparatively small, and not necessarily representative, sector of the area's population. To supplement our public involvement program, the Huntington District contracted with Marshall University and the West Virginia Department of Employment Security to obtain a social-economic profile of the area. The emphasis was to be on the attitude of the residents of Cabin Creek toward water resources development. The major components of this survey effort were a carefully designed questionnaire and direct contact with about 30 percent of the families residing in the area.

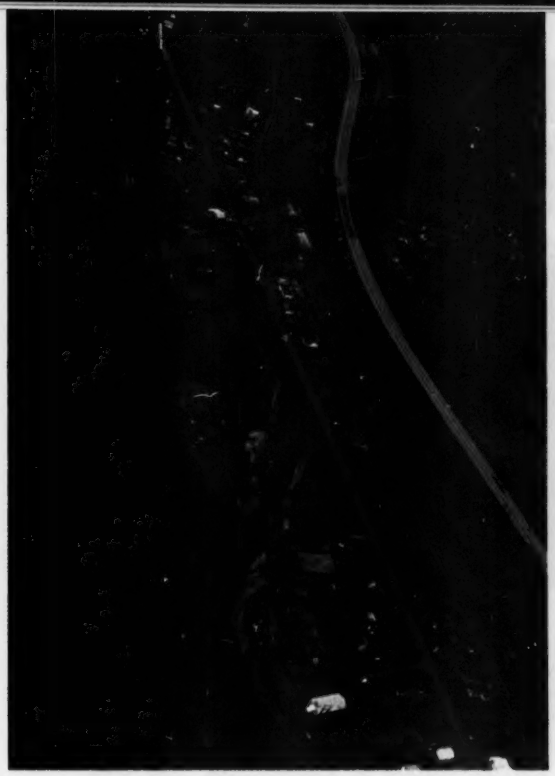
While the survey provided extremely useful economic and other statistical data, the information on insights and attitudes of the people was of primary value. In analyzing the results, Marshall University's Department of Sociology and Anthropology observed that the residents of the area were acutely aware that their social and economic problems had been subjected to a variety of attacks, each of which had consistently fallen short of sustaining any major improvements. The analysis concluded that most residents viewed an overall development approach to the problems of the area as the only viable solution to their problems. This insight permitted plan formulation to proceed with reasonable assurance of public acceptance.

Second, an informal liaison was established with representatives of the area's coal mining industry. A series of informal meetings provided a beneficial exchange of viewpoints and information—in particular, an understanding of the area's problems from the mining industry's point of view. This liaison indicated that the mining industry had a genuine concern for mining-related problems in the area and would be willing to participate in a reasonable rehabilitation program.

Third, liaison was maintained with appropriate governmental agencies at the Federal, State and local levels. In addition, collaboration was maintained with the West Virginia Department of Natural Resources and the Kanawha County Regional Development Authority. This interagency cooperation culminated in a plan formulation workshop which involved cross-sectional participation by local, State and Federal agencies.

Four Alternatives

The interaction resulted in a definition of four alternative plan concepts. These plan concepts ranged from a do-nothing alternative to an essentially comprehensive and total redevelopment of the watershed in terms of water and related land management. The do-nothing alternative was particularly useful as a point of reference to give perspective to the problems of the watershed. A second plan encompassed limited reclamation and alleviation of flood problems through appropriate structural measures. A third plan expanded the second plan to



Left-Intensive development on Cabin Creek's narrow flood plain concentrates population on 2 percent of watershed land.

Revegetation through hydroseeding quickly stabilizes strip mined area.

provide for domestic waste collection and treatment facilities and improved water supply.

The fourth and most ambitious plan provided for a comprehensive attack on water and land management problems. It included appropriate measures for sediment and erosion control, flood protection, water quality management, water supply, recreation, and related social, economic, and environmental concerns.

A tentative plan of improvement consisting of most, but not all, components of the comprehensive rehabilitation plan was selected and presented to interested and involved parties in the two-part form of a draft environmental impact statement and a subsequent formal public meeting.

Since the formal public meeting was a consummation of an elaborate and carefully structured public involvement process, it was anticipated with a mixture of enthusiasm and apprehension by the District's planning staff. A basic question was how would the populace of the Cabin Creek area respond to a relatively sophisticated and elaborate rehabilitation program in the uncomfortable trappings of a formal public meeting. The results were a high level of understanding, response, and support of the tentative plan. The range and type of comments were interesting and enlightening. For example, the spokesman for a principal local action group moved that all mention of a do-nothing plan be deleted from the public meeting record.

Generally, one specific exception was taken with the tentative plan. To minimize total investment cost, the plan encompassed a rehabilitation and expansion of existing private water supply systems as opposed to development of a regional distribution system. This was widely regarded as impractical by public meeting participants. Subsequent to the public meeting, local governmental interests submitted significant data on the hazards to public health and welfare posed by the existing water supply sources and distribution systems. These data were carefully evaluated and regarded as adequate justification for adding a regional water supply system to the plan.

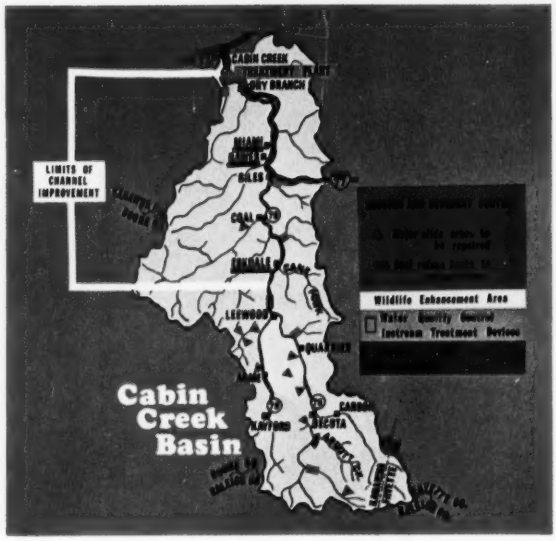
Six Categories

The plan formulated contains six basic categories of projects and measures that would rehabilitate the watershed and alleviate its major water resources problems in a coordinated, time-phased manner. These are erosion and sediment control, flood control, water quality control, water supply, general recreation and fish and wildlife enhancement, and social, economic and environmental improvements.

Several levels of land reclamation are proposed to effect erosion and sediment control. Some 31 major earth slide areas encompassing about 828 acres of unstable outslope spoil would be treated. These spoil slopes would be regraded and terraced. Runoff would be controlled by diversion ditches, drains and water-checks. The soil would be conditioned, mulched and seeded. It is also proposed to utilize secondary-treated effluent and digested sludge to enhance and accelerate soil enrichment efforts on a limited, carefully controlled test basis.

Early action is proposed for those major land disturbances which are causing gross pollution and threatening cultural improvements. Such action includes treatment of those unsightly "gob piles" of mine refuse banks. A sediment entrapment basin would be constructed on the

Basin residents would add the goal of social, economic and environmental improvements to those illustrated here for the tentative plan of development.



Heart of Eskdale contains dilapidated buildings that might be demolished to improve community's social environment under the tentative plan of development for the basin.

upper main stem of Cabin Creek in an effort to provide a measure of bedload control for material entering the creek and reduce the frequency of flooding.

To accomplish flood control for the heavily inhabited areas of the watershed, it is proposed to rehabilitate the channel of Cabin Creek for a distance of 10.5 miles. This project includes sediment removal, channel modification and realignment, removal of snags, clearing and grubbing, slope protection and seeding. In addition, a flood plain management program would be implemented to provide effective planning for future development in the Cabin Creek valley. Besides improving the hydraulic efficiency of the stream and reducing flood damage, these efforts would help combat the emotional trauma residents always mentioned in connection with periods of heavy rainfall.

Water quality control would be accomplished by attacking acid mine drainage and providing treatment of domestic wastes. A pilot program would locate the acid producing sources, ascertain the magnitude of water reaching these sources and evaluate the feasibility of implementing a corrective project on a permanent basis. Where feasible, acid mine drainage improvement would be accomplished by intercepting and diverting uncontaminated ground water from the pollutant sources. Of course the most developed areas of the valley would be served by a domestic waste collection and treatment system. Water quality improvement would also benefit stream flora and fauna.

The proposed water supply system would consist of a dependable treatment plan and distribution system that would eliminate the hazards of relying on unsafe sources.

Initial recreation improvements will focus on day-use miniparks and development of public hunting areas. However, if Cabin Creek itself can be made to support a thriving aquatic life, it may be stocked with fish at a later period.

To further improve the social environment of the area it is proposed to remove dilapidated and abandoned buildings, institute a program of solid waste disposal, construct a community center and provide for the removal of junk cars, trash and other unsightly debris.

Benefits

Implementing the demonstration program would cost about $14 million and would depend on fully coordinated actions by Federal, State, and county governments, industry and the citizens of Cabin Creek. The cost sharing will have to be determined based on the various Federal interests involved but it is estimated at least 25 percent of the cost would have to be non-Federal.

The program, if authorized, would probably be accomplished sequentially over a period of 10 years to provide flexibility, economy, and evaluation opportunities. While a shorter implementation period might be desirable, the magnitude of local costs would preclude accomplishment in a shorter period. A major aspect of plan implementation would include minimizing construction costs and adverse environmental impacts through a construction program coordinating the proposed channel rehabilitation and sewer and water systems with proposed highway construction by the State of West Virginia.

We have learned from our study that traditional measures of dollar benefits alone would not be sufficient to balance the costs of the total program. But then the full program would produce highly important, even though intangible, social and environmental benefits as well as the more obvious tangible economic returns. The Cabin Creek Demonstration Project report is merely one vehicle through which the residents of an Appalachian subregion might move toward a more positive future.

The technical feasibility of such a unique social-environmental reclamation project is being closely examined by the Corps in preparing the final report for forwarding through the Secretary of the Army to the Office of Management and Budget.

One of the most important policy issues requiring consideration, both by the Executive Branch in its recommendations and by the Congress in its final action, will be to decide the relative weight which should be given to these intangible benefits. ■

PUT TO THE TEST

by David M. Rockwood
Chief, Water Control Branch
North Pacific Division

Effective reservoir control and water management tamed a major flood and overcame a widespread drought in the Columbia River Basin.

The coincidence of nature's whims with near completion of the Columbia River reservoir system put the design to the test in an unexpected "real world" context. Within a brief 2-year span nature unleashed two of its most devastating weapons—flooding and drought—on the Pacific Northwest.

A near-record flood runoff occurred in the Columbia in 1972. This was followed by a near-record low-water period in 1973 which, in turn, was followed by another high-runoff period this year.

Such extremes of wet and dry periods do not normally occur back-to-back in the usual cycle of Columbia River Basin events. Therefore, the past 2 years have been what constitutes an unusually premature, but nevertheless effective, test of the new system. It has operated essentially according to plan.

The 1972 flood could have been a major disaster of a magnitude ranking with the Tropical Storm Agnes flooding on the East Coast. However, use of the system's multipurpose reservoirs according to a preconceived plan tamed this flood to relatively nondamaging proportions.

Then the system was immediately called upon to conserve its water resource to alleviate the hydroenergy shortage that occurred during the summer and fall of 1973. Although the principal multipurpose values of the system were preserved, special energy conservation programs were put into effect during the period of shortages.

The basic problem in both situations stems from the fact that the Columbia River is the major snow-fed river in the country, outside of Alaska. The river's 259,000-square-mile basin drains the rugged mountain regions of Oregon, Washington, Idaho, the western part of Montana and some 39,500 square miles in British Columbia, Canada. Each spring the runoff from melting snow in the mountains gradually increases to an annual peak flow usually reached during the first half of June. Thereafter, streamflows recede and diminish down to base flow by early autumn. Occasionally, though, secondary winter peak discharges occur from unusually heavy rainfall—such as happened during the early months of 1974. By the time this runoff reaches the mouth of the Columbia it averages 180 million acre-feet annually.

The 1972 Flood

In the spring of 1972 the snow accumulation over the entire Columbia River Basin was so much above normal that very high runoff was expected with the melting of the snow in late spring and early summer. Forecasts of flood peaks and volumes indicated that amounts equal to or greater than those observed over the past 50 years would be experienced without the use of reservoir control. The key question then became: what degree of regulation could be counted on by the not quite completed reservoir system?

A fortunate circumstance encouraged optimism about the reservoir system's ability to control the coming flood to manageable levels. This was the fact that the new Dworshak and Libby Dam and Reservoir projects were being put into operation as part of a network of 77 major dams and hydroelectric projects in the Pacific Northwest, most of which were integrated into the Columbia River system either hydraulically or electrically.

Although Dworshak and Libby could only be counted on for partial use of their respective water storage capabilities at that time, they still added about 5 million

Only five months separate these views of southern Oregon's Applegate River taken from the same site August 1973 and January 1974.

The Columbia River Basin's reservoir program is being developed jointly with Canada under the international Columbia River Treaty.

acre-feet of usable storage space to existing projects in Canada and the United States. This increased the total usable storage area by more than 20 percent, providing a total of about 24 million acre-feet. While this amount did not provide the capacity envisioned for the fully completed operational system, it was sufficient to prevent a major flood catastrophe.

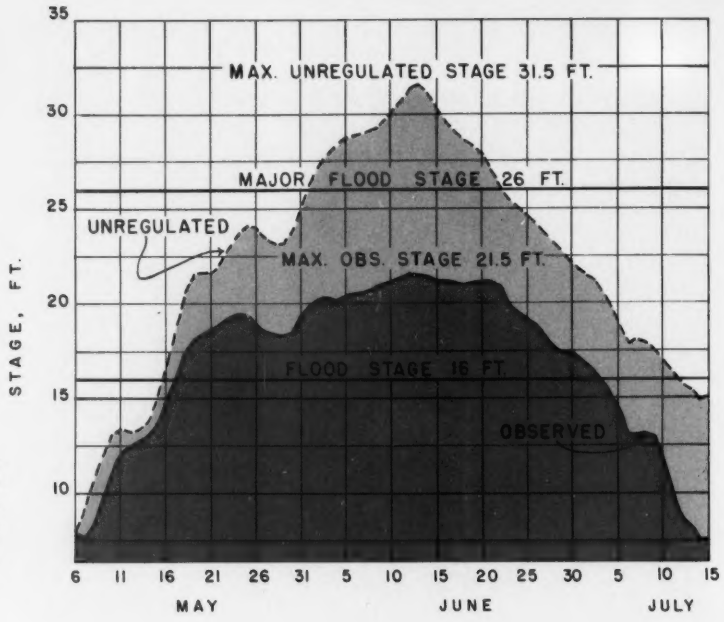
Thus, it was recognized in advance that the control system was at least developed to the level where it could be put to the test in a real-time operation. Preparations were made to provide the necessary reservoir space. Computer simulation techniques were put in readiness for making day-to-day reservoir control decisions based on hydrologic and reservoir regulation forecasts.

As it turned out, the flood did indeed develop as foreseen. The hydrometeorological conditions during the snowmelt period were particularly severe. The unregulated rivers and streams in the basin reached unusually high discharge levels over a prolonged period of time. Many anxious days were spent by the Water Control Branch of the North Pacific Division in analyzing and evaluating computer-derived forecasts for the next 30 or more days. The purpose of these forecasts was to account for the changing flood potentials as the snowpacks melted and the reservoir storage conditions changed, while also considering the amount of regulation needed to meet all the usual operational requirements—such as hydroelectric power generation, irrigation, navigation, water quality, fish and wildlife management, and recreation.

The results of the regulation did, in fact, meet all the requirements within the limited capability of each project in the system. The flood—which would have reached a crest discharge of 1,053,000 cubic feet per second (cfs) at The Dalles, Ore., without reservoir regulation (higher than the disastrous flood of 1948)—was controlled by regulating the Columbia River flow down to a peak discharge of only 620,000 cfs.

Controlling maximum flow produced a peak river stage of 21.5 feet at Vancouver, Wash., where the bankfull stage is 16.0 feet and major flood stage is 26.0 feet. Without the storage reservoirs, the crest stage would have been 31.5 feet. Similar reductions in flood stages were produced at many upstream locations, both on the main stem of the Columbia River and on those tributaries controlled by reservoir storage. For this flood alone, the damages prevented by reservoir storage amounted to $260 million.

Much of the ability to achieve the reservoir regulation described above lies in the use of computerized streamflow simulation models. The North Pacific Division



Coordinated reservoir regulation of the Columbia's main stem limited the June 1972 high water to only 5.5 feet above flood stage at Vancouver, Wash., near the confluence of the Willamette and Columbia Rivers.

developed and has, for many years, routinely utilized a particular series of computer simulation models known as the Streamflow Synthesis and Reservoir Regulation (SSARR) Package. This effort has been enhanced by the Portland River Forecast Center of the National Weather Service under a joint agreement between the two agencies since 1962.

Recently, the Bonneville Power Administration joined this coordinated effort to provide forecasts for water management of the Columbia through the Columbia River Forecasting Service. The nerve center of the whole operation is the U.S. Custom House in Portland, Ore., headquarters of the Columbia River Forecasting Service and the Corps' Reservoir Control Center.

Effective control of a major flood, however, requires the cooperative efforts of many organizations. In addition to those already mentioned, the coordinated flood effort involved the Bureau of Reclamation, the British Columbia Hydro and Power Authority and many public and private power utility companies. There were also the State and Federal agencies responsible for streamflow and weather monitoring and analysis, the emergency organizations who may be called in to act if trouble should develop, and a host of organizations responsible for the other river and reservoir uses—irrigation, recreation, navigation and fish and wildlife management.

The 1973-74 Hydroelectric Shortage

It was indeed ironic that the year of high floods in 1972 was followed by a year of drought in 1973. In terms of severity, the light snow accumulation in the spring of 1973 resulted in runoff volumes so low that only 2 of the 95 years during which records have been kept had lower runoffs.

The water supply from melting of the spring 1973 snowpack was insufficient to refill the reservoirs which had been evacuated to supply power demands in the preceding winter. At the end of the refill period, the reservoir system contained only 22 million acre-feet of water compared with the approximately 29 million acre-feet of total refill capacity available. Because of this deficiency, special measures were taken to reduce electrical energy consumption in the Pacific Northwest. These efforts were almost entirely centered on voluntary measures by the general public and commercial and industrial power users. Such measures reduced system power loads by perhaps as much as 5 percent.

Also, special water conservation measures were taken to provide more efficient use of the water available for power production through modification of normal reservoir regulation criteria. These included reduced use of water for fish passage facilities during the late fall when migration of anadromous fish had virtually ceased. There was also some relaxation of certain operating limits at some of the run-of-river projects. However, the major operating criteria for flood control, navigation and irrigation remained in effect. Only the effectiveness of recreational use was reduced at a few of the reservoirs in the system. The article in the last issue of WATER SPECTRUM written by Don Hodel, Administrator of the Bonneville Power Administration, describes in detail the power aspects encountered during the fall of 1973 drought.[1]

Fortunately, this particular low-water period has passed. Heavy rains and mountain snowfall during the months of November 1973 through March 1974 changed the hydrologic balance of the Columbia system from a water deficit to a surplus. In fact, severe flooding occurred in January in the coastal rivers and low-elevation tributaries of the interior. However, normal winter flood control operation of the system's reservoirs provided significant flood reductions in the Willamette and lower Columbia Rivers.

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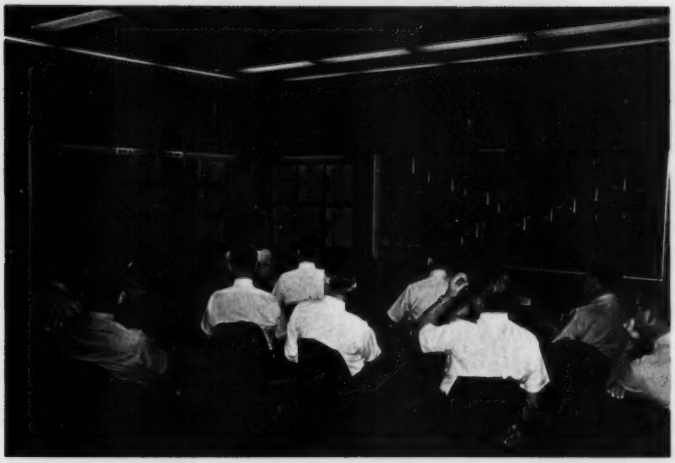
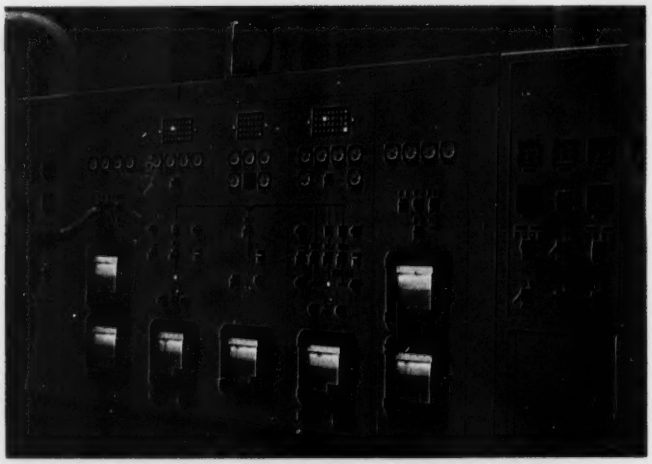
[1] "Northwest Power Crunch," Vol. 6, No. 1, 1974, pp. 1-7.



Here at Portland, Ore., is the nerve center of the Reservoir Control Center and the Columbia River Forecasting Service.

Center- An unregulated Columbia River could have severely damaged downtown Vancouver if the river had gone above major flood stage during the near-record 1972 runoff.

Bottom- Libby Dam's new reservoir was being integrated into the Columbia River reservoir control system along with Dworshak's as 1972's high water period approached.



Right-Control-panel operator at McNary Dam coordinates his reservoir's activity with the control center at Portland.

Below-Fish ladder flows during the 1973 drought were reduced that fall, as soon as upstream fish migration stopped, to conserve the limited water supply.

Below right-Snowpacks melting in the late spring and early summer make the Columbia one of the major snow-fed rivers in the United States.

In retrospect, last year's low-water period provided a good example of the system's capability to meet its power commitment under adverse water conditions. The system has been designed to meet the most severe sequence of natural events that has ever been experienced in the area since records have been kept. However, when the reservoirs failed to refill, there was concern about the possibility of the most critical sequences of water conditions on record recurring in the wake of an already deficient water supply situation. Obviously, this would have involved a theoretical sequence of events which would have been more severe than any real occurrences of the past. Fortunately, the ever changing seasonal supply of moisture in the region conformed to historical statistical variations.

When we were operating the system in "real time," though, there was considerable pressure to relax certain aspects of the multipurpose reservoir regulation criteria. However, the recent occurrences illustrated that, although minor modifications were instituted, the major multipurpose aspects of the system were preserved.

The Columbia is now a nearly fully developed system of reservoirs and hydroelectric projects. Since there is such a wide variety of ownerships and operating authorities for individual water control projects, the current system of coordination has come about by the voluntary actions of various interests.

The projects in operation in the Pacific Northwest generally consist of multipurpose reservoirs upstream and run-of-river navigation and hydroelectric power projects downstream. Of these major projects, 29 are Corps operated multipurpose projects, 20 are Bureau of Reclamation multipurpose projects, 23 are non-Federal hydroelectric projects and 5 are multipurpose or hydroelectric projects located in the Canadian part of the Columbia River Basin. The Corps has been instrumental in coordinating these projects into an integrated system.

The usable storage in reservoirs for downstream control of the main stem of the Columbia is about 40 million acre-feet. In addition, there are numerous small reservoirs constructed by local interests for irrigation use. The electrical transmission network constructed by the Bonneville Power Administration integrates the Northwest electrical generation facilities operated by the various government agencies and private utility companies. The total capital investment in these projects, including transmission facilities, is estimated to be about $10.5 billion.

The values represented in the beneficial uses of water in this system are almost beyond comparison in terms of how well the water is utilized for all its multiple pur-

Upstream reservoirs on the Willamette River protect the heavy concentration of industries at Portland Harbor from severe flooding.

poses. This system has the most highly developed hydropower resource of any major river basin in the world. It has some 20.9 million kilowatts of installed hydroelectric capacity, and the total will increase to 27.8 million in the next few years. By comparison, the installed hydroelectric capacity in the Tennessee Valley Authority system is about 4.4 million kilowatts. If the Columbia system's 100 billion kilowatt-hours of hydropower were generated by oil-fired thermal power plants instead of hydropower, the electrical energy produced in the system this past year would have required the consumption of some 185 million barrels of oil.

Flood control benefits resulting from reservoir regulation have averaged well over $100 million annually for the past 10 years. The Bureau of Reclamation estimates that the value of crops produced on lands irrigated by the waters of the Columbia system averages more than $600 million annually. These crops, directly or indirectly, produce the agricultural products to feed approximately 5 million people.

Navigation through the up-river lock and dam system now carries in excess of 4 million tons annually, and is steadily increasing as the navigation system is being completed. Oceanborne commerce in the lower Columbia between the Portland-Vancouver area and the Pacific Ocean—approximately 105 miles—is over 20 million tons a year.

The annual commercial and sport fishery value of the anadromous fish runs harvested from those species of salmon and other fish originating in the Columbia system is estimated by the National Marine Fishery Service to be about $30 million. Water-based recreational use of Federal reservoirs in the Pacific Northwest was recorded at over 22 million visitors last year for purposes of sightseeing, fishing, camping, picnicking, swimming and boating.

A high degree of water quality enhancement of the Willamette, a tributary of the Columbia, has been achieved through low flow augmentation provided by the reservoir system. This effort has been coupled with State and locally sponsored water pollution control facilities for municipal and industrial wastes.

Future Outlook

Within the past 2 years the Columbia system has reached a plateau of reservoir development with the near completion of projects related to the Columbia River Treaty for joint development of Canadian and United States water resources. The improvements scheduled to be undertaken within the next 15 to 20 years are mainly concerned with the construction of additional hydropower facilities at existing plants. The exceptions are those local projects on tributary streams which have little or no effect upon the main system.

The additional units which will be constructed were authorized in connection with the Federal and utility-sponsored Hydro Thermal Power Program for the Pacific Northwest. Although not immediately installed, the provision for additional hydroelectric generating turbine units was constructed into each of the new dams with the future in mind. Projections of future loads versus available resources indicate that there will be, generally, a deficit in meeting normal energy and peak power demands for electricity for many years to come. Since this projection is based on critical water supplies, any unusually low streamflow conditions will put additional stresses on the power system. It is our principal objective to maintain this balance of supply and demand for all types of water use through multipurpose regulation of the system in accordance with the present authorizations, licenses and operating criteria imposed upon us.

The flood control system now in existence with the completion of the new Mica Reservoir project in Canada—together with all other projects now in operation in Canada and the United States—provides us sufficient assurance for the future. We now have the storage regulation capacity to control floods of a magnitude equal to the largest on record. Even the Standard Project Flood, a computer simulated set of flooding circumstances considerably more severe than any which have been experienced, would be controlled sufficiently to prevent a major disaster to the area.

Some may feel we have unnecessarily overbuilt our regional hydropower and reservoir capacity. Yet when potential disasters struck the Pacific Northwest in rapid succession within a 2-year period, our system was put to the test and passed with exceptionally high marks—both in flood control and water conservation. ■

Events, Deeds & Deliberations

Lakeshore Management

The U. S. Army Corps of Engineers is revising its lakeshore management policies in an effort to preserve public access and environmental values at Corps managed lakes. The proposed regulation was published in the Federal Register May 30, 1974, and the Corps is currently reviewing the public's comments on this proposal.

There are currently some 20,000 private floating recreation facilities and about 16,000 permits for landscape alterations (such as clearing trees and brush) concentrated on approximately 120 of the 400 lakes under the jurisdiction of the Corps.

The problem of private exclusive use of public lands has reached epidemic proportions at some lakes. For example, at Lake Sidney Lanier near Atlanta, Ga., each mile of shore averages 5.5 private docks or about 1 every thousand feet. In addition, an average of 5.2 landscape permits per mile have been issued by the Corps. At Old Hickory Lake, outside Nashville, Tenn., there are 2.6 private docks and 3.7 landscape permits for each mile of shoreline.

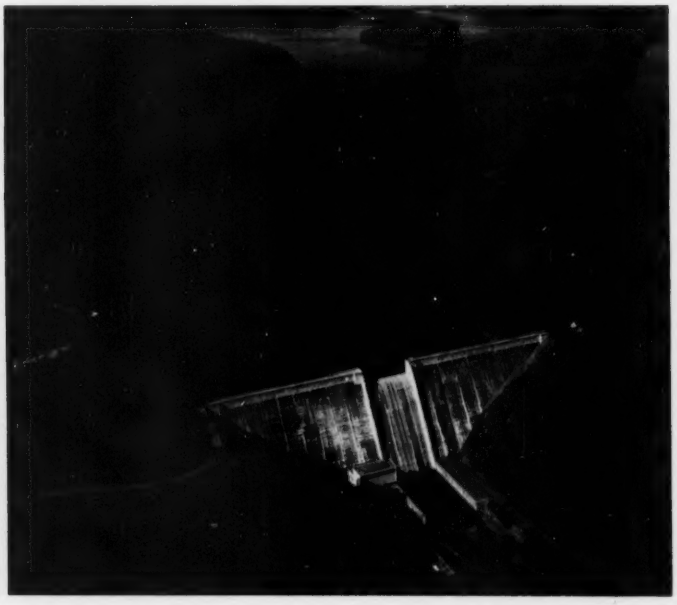
The main reason for the proposed regulation is the gradual encroachment of private use on public shorelines. The problem began in the early days of Corps water resource development when recreation demands were still relatively low. The policy of "minimum acquisition" of shoreline land at Corps projects, which was developed during the 1950s, encouraged owners of private property adjacent to the narrow strip of Government owned shoreline to request permission to place boat piers and swim floats along the shore and modify the landscape between their properties and the lake.

This situation created no problems as long as there were relatively few adjoining landowners and public visitation was light. The increase of affluence and leisure time in the United States brought an accompanying desire for second, or vacation, homes with scenic lake views and waterfront amenities.

There were few restrictions on the issuance of either pier or landscape permits until the demand became overwhelming in recent years. Resource managers at Corps projects saw more and more public access and wildlife habitat being infringed upon until it began to appear that property fronting large areas of public lakes implied private ownership of segments of public shoreline. Meanwhile the number of nonresident visitors also increased, creating a greater demand for public access to the shoreline.

This increased interest in recreation activities at Corps lakes has grown more than tenfold since 1952, when only 30 million recreation days were recorded. Last year's statistics showed 340 million recreation days.

Shorelines of some Corps lakes are natural and pristine while others are cluttered with private boat docks and access roads. The proposed regulations will provide for proper management of the lakeshore to allow maximum public use at minimum environmental cost.



The More The Merrier

Recorded visits to recreation areas at Army Corps of Engineers projects during 1973 reached a new high—344 million—15 million over the 1972 total.

Most heavily visited among the nearly 400 Corps-managed recreation areas were Lake Sidney Lanier, near Atlanta, Ga., and Lake Texoma, which sprawls across the Texas-Oklahoma State line due north of Dallas. Nearly 14 million visits were recorded at Lanier in 1973, and over 10 million at Texoma.

Can't Beat The Price

A $25 reclamation project? That's what Dr. Calvin Fremling and his environmental class at Winona State College are undertaking as an outdoor education experience.

Their project, under way near Buffalo City, Wis., consists of planting an assortment of experimental ground cover seeds and common weed seeds on a pile of dredged spoil. If the experiment is successful, the vegetal growth will stabilize the spoil, reducing the amount of sand that normal wave and wind action would return into the dredged channel.

The $25? That was to buy fertilizer to provide nutrients initially lacking in the spoil pile.

Computerized Sewers

Many communities continue to use dual-purpose sewer systems, in which the sewers serve as channels to collect and discharge both storm water and waste materials. If storm water runoff exceeds the capacity of the sewer channel, the resultant overflow spills out waste-contaminated storm water.

To reduce such overflows, Seattle, Wash., has developed a computer system that ties into the municipal sewer system. Right now, the computer's operation is half automatic and half human-directed. Remote terminals measure the amount of rain falling at several points in the metropolitan area and the amount of water already in the sewers. If the computer calculates that the total might cause an overflow, the computer issues instructions to control the level in the waterlines. Regulator gates, both upstream and downstream, are directed either to close or open. Sewage pumps are directed to speed up the flow.

Although not yet fully automatic, the Computer Augmented Treatment and Disposal (CATAD) system has been 80 percent effective in reducing overflows. Ultimately all vestiges of human direction will be eliminated. At that time, it is hoped that the completely automatic system will be 90 percent effective in reducing overflows and will be capable of predicting the volume of future stormflows entering the system after computing such factors as amount of rainfall, degree of runoff, size of drainage area and type of surface.

The Future?

Increasing heat pollution could eventually cause the flooding of earth's coastal cities, including London and New York. This was the prediction of a speaker at the American Geophysical Union's last annual convention.

If consumption of energy from fossil fuel, nuclear and geothermal sources continues to increase at 4 percent a year, he warned, the heat pollution will cause the polar ice caps to start melting a hundred years from now. About fifty years thereafter, the melted ice would have raised sea levels 200 feet, thereby flooding about 10 percent of the earth's low-lying land areas.

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The Largest

Brazil and Paraguay are jointly undertaking construction of the largest hydroelectric project in the world. The Itaipu Dam, to be built on the Parana River, will be completed in the early 1980s. When completed, the dam will produce 10.7 million kilowatts per hour or five times more than Egypt's Aswan Dam.

Frustrated Beaver

Chief ranger Frank Funk contemplates the evidence of a frustrated beaver at Tuttle Creek Lake, north of Manhattan, Kans.

Each night last fall, when the beaver returned to his favorite tree, he discovered the spot on the tree trunk that he had gnawed before was well above the receding pool elevation of the lake.

The pool elevation had been 53 feet above normal while the lake held back potential floodwater resulting from heavy fall rains.

In typical beaver fashion, the beaver would try again to topple the tree. But even beavers have their limits. He finally gave up and moved out.

There are no fresh signs of beavers in the area.

Oregon's Newest Railway

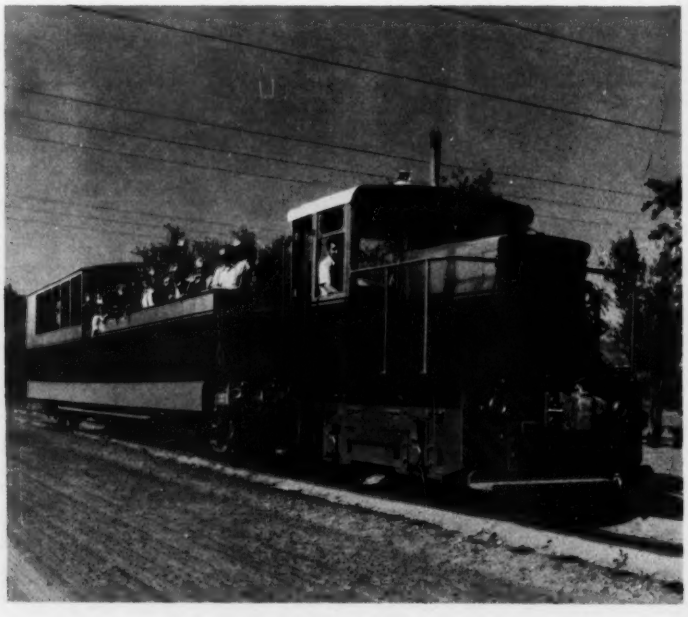
Months before the threat of gasoline shortages filled trains to capacity, the Corps of Engineers' Portland District was getting a two-car railroad ready to carry future crowds of passengers around the area at The Dalles Dam on the Columbia River.

The railroad's two pieces of rolling stock are a 25-ton 1942 model diesel-electric yard engine and a 52-foot flatcar converted into an open-air passenger car to take advantage of the usually clear weather at The Dalles.

Portland District calls its railway a strictly low-budget operation. The district obtained the engine from surplus materials storage in California, and purchased the flatcar from a contractor who had finished major work at the dam. The train travels on track from an existing right-of-way which the Corps maintains to deliver heavy equipment to the dam powerhouse.

During the tourist season, the bright yellow and green ensemble carried an average of 1,500 visitors a week over its two miles of track, looping from riverside Seufert Park to points of interest at the giant hydroelectric dam. Visitors can disembark from the guided tour at several stopping points, sightsee, and reboard the train on a later circuit.

During the months of peak visitation when the train is operating, visitors can park their cars at perimeter lots and board the train to points of interest. A shortage of space combined with a surge in the number of trailers and large vehicles touring the project had created severe parking problems at several viewpoints. Visitors who take the train tour avoid the traffic jams.



Let The Rain Seep Through

Can a permeable asphalt replace the traditional nonporous asphalt used to blacktop roadways and parking lots? If it can, the porous asphalt would increase ground water supply, decrease floods and runoff, reduce glare, and prevent wet skidding and hydroplaning.

An experimental porous-asphalt blacktop laid on a 140- by 240-foot parking lot at the University of Delaware in Newark, Del., survived the winter of 1973-74 without any problems. It behaved as expected. Although some loosening of material did occur, it is believed that this was caused by a corner of a snowplow blade. Designers of the porous asphalt feel that from the choices of material involved in the design there should be no problem with regard to durability.

Although the porous asphalt resembles the nonporous in appearance, the porous consists of coarse material only. To compensate for the removal of fine materials, a slightly larger amount of asphalt is used for binding. Rainwater is retained in the spaces between the coarse material until the water can percolate into the soil.

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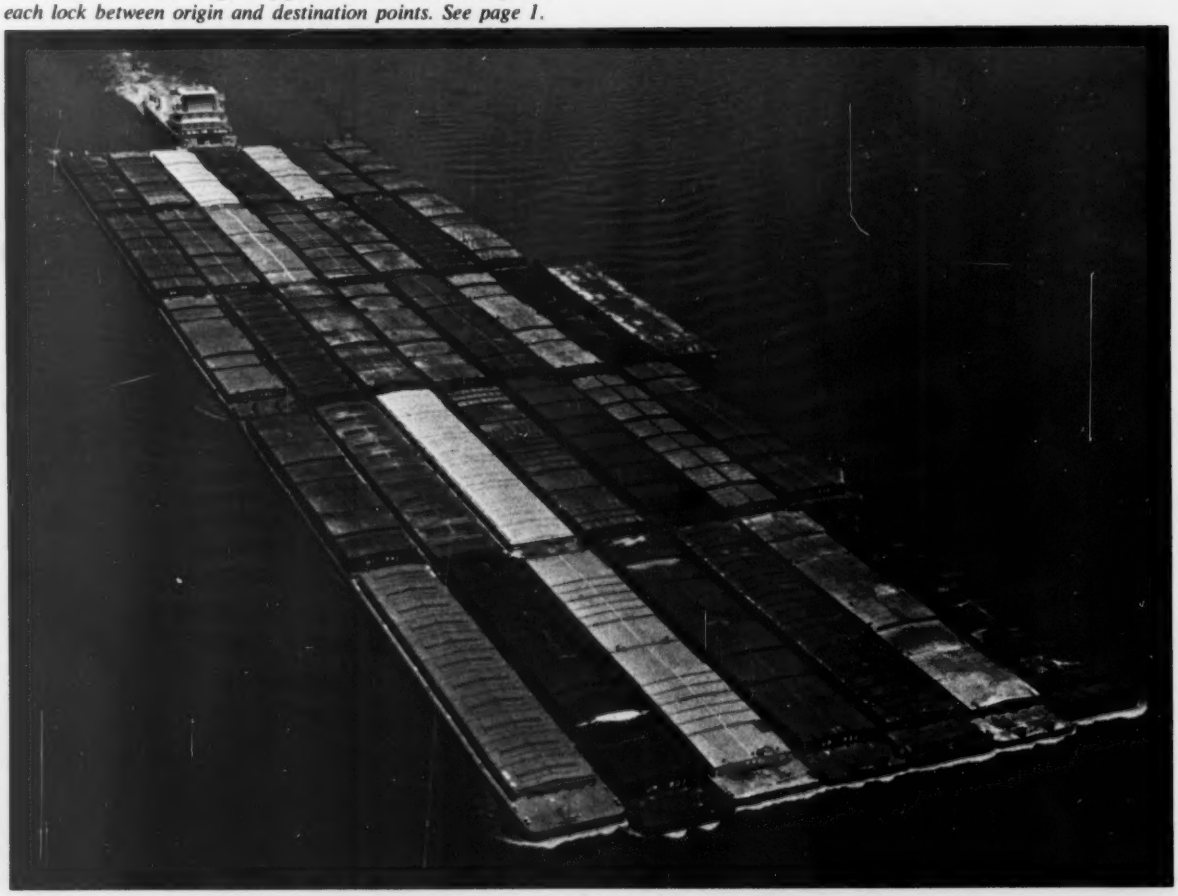
Tows such as this 36-barge configuration must be rearranged at each lock between origin and destination points. See page 1.